SCIENTIFIC AMERICAN
No. SUPPLEMENT 100

Scientific American Supplement, Vol. IV, No. 100.
Scientific American, established 1845.

NEW YORK, DECEMBER 1, 1877.

Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a year.

THE NEWTON DREDGING MACHINE.

OUR engraving represents the dredge now in operation on Galveston Island, harbor of Galveston, Texas. In this *A* is the suction pipe lowered to one of its many working positions; *B B*, vacuum chambers; *C*, vacuum column or dome to equalize pressure; *D*, discharge pipe; *E*, steam and water pipes; *F*, swivel or turntable on which discharge pipe revolves.

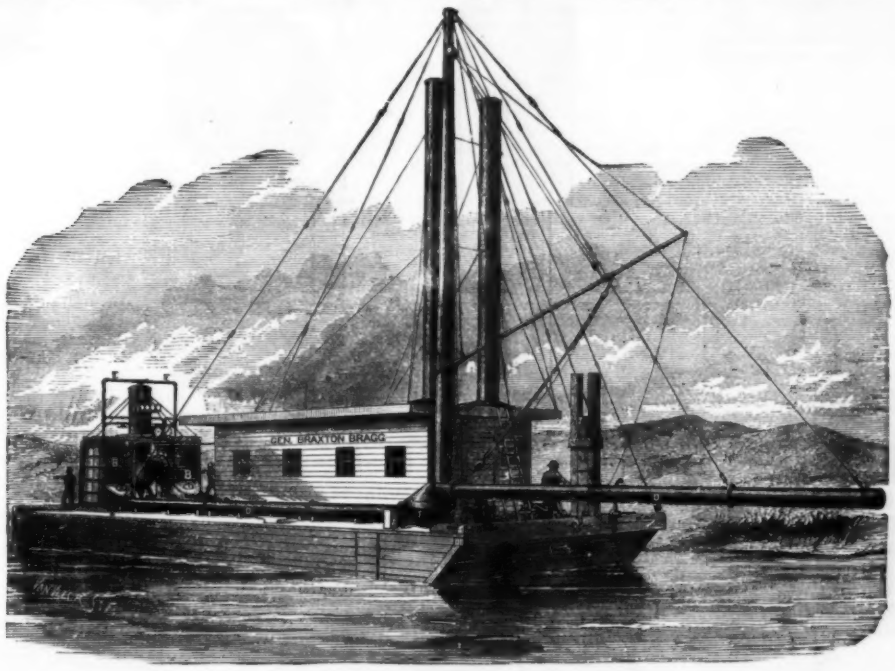
The owners give the capacity at 5,000 cubic yards in 10 hours, and state that it works continuously in a satisfactory manner.

The principles employed in the Newton hydraulic dredge are a combination of the well known forces of hydrostatic pressure, the formation of a vacuum by steam pressure and sudden condensation by means of cold water injected in the vacuum cylinders, and the disintegrating force of water jets discharged against the mineral to be dredged, at a velocity of 250 feet per second. The operation of the dredge may be briefly described as follows:

The suction pipe, to which three disintegrating or "digging" pipes are attached, is lowered through a well in the boat containing the machinery, until its lower end rests upon or is near to the material to be elevated; a vacuum is then formed by driving the air from the vacuum cylinders by steam from the boilers, and at the moment when the air is thus expelled the steam is condensed by the sudden injection of cold water, and the material comes from under the pipe, whether it is mud, stone, gravel, or clay. There being two vacuum cylinders, working alternately, governed by a large dome, the steam from the discharge pipe is continuous. The dredge is capable of working in any kind of material, and anything which will pass through the pipe can be raised. In fact, in several instances, the Galveston dredge brought up large pieces of anchor chain from the bottom of the bay, showing that pieces of rock and debris not larger than the pipe can easily be removed by the device. The suction pipe is telescopic, and the number of joints is regulated by the depth at which the machine is to work.

This machine will be extremely valuable in the tule lands of this State where so much dredging and levee building is done. The levees can be built by the dirt drawn up from the bottom of the sloughs or rivers and deposited by the machine in the proper place, 600 or 1,000 feet distant, without rehandling. By this method the work can be done very rapidly and cheaply, and the levees can be built higher, wider, and stronger than they usually are. The work of building levees in this State, along the tule lands, is one of large proportions, and hundreds of thousands of dollars are annually spent.

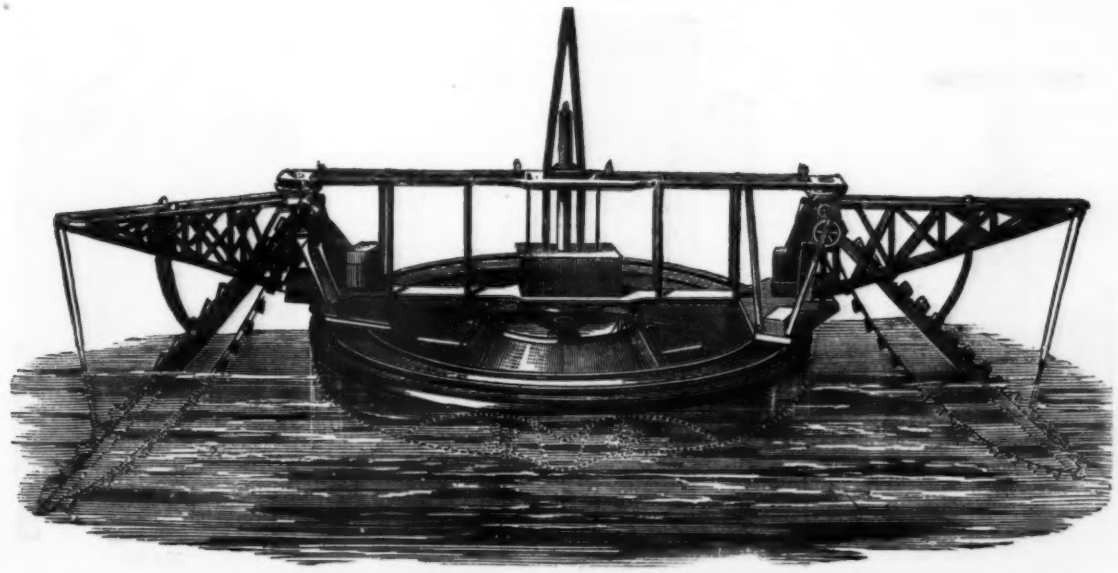
It is intended also to apply the Newton dredge to the purpose of river mining, a new method of mining now coming into vogue. In this class of mining the auriferous material is pumped up from the bottoms of the rivers which carry water enough to float the dredges. This dredge can take the material from below and discharge it high enough so that its golden contents may be sluiced off and saved.—*Min. and Sci. Press.*



THE NEWTON HYDRAULIC DREDGING AND MINING MACHINE.

KINIPPLE'S DREDGING OR EXCAVATING MACHINE.

WE illustrate a circular radial dredging machine, designed by Mr. W. R. Kinipple, C.E. Westminster, England, for dredging afloat or aground without the usual aid of bow, side, and stern chains. The machine consists of a circular vessel having a round well or hopper and a revolving framework carrying the engines, machinery, and radial bucket ladders. In the centre of the vessel is a cylindrical screw pile, which is screwed into the bottom of the sea or river, at any spot where dredging operations are to be carried on. The pile is hollow, and is filled with water to aid its descent by weight; the water is pumped out to give additional lifting power during the process of rising. Around the pile there is freedom for oscillation in a moderate seaway. There are two revolving anchors carried by legs, which are lowered down to the bed of the sea. These provide additional mooring power beyond that obtained by the centre screw pile, and for the purpose of giving a rotary motion to the dredger when she is at work. On the deck of the hull, at the outer margin, is a rail, on which the radial dredging machinery revolves or travels. There are two radial bucket ladders, which, when dredging, may be worked in opposition to each other, so as to place the machine in equilibrium.



KINIPPLE'S DREDGING MACHINE.

The travelling framework supporting the radial ladder may be secured in a fixed position to quay or wharf, and the hull of the dredger made to revolve, while one bucket ladder is working radically and loading the hopper, and the other is unloading the hopper and discharging the dredged materials into an embankment behind the quays. This class of dredger is considered by the inventor to be well adapted for cutting canals for their full width, while working along a centre line. It may be used as a hopper dredger, or an ordinary fixed dredger; and a great advantage is that so very short a time would usually suffice to secure the circular dredger in position in any locality for dredging operations.

The circular dredger may be looked upon as the most recent step in connection with the hopper dredger system. The largest hopper dredger afloat at the present time is the Greenock, owned by the Greenock Harbor Trustees; it was built by Messrs. Simons and Co., of Renfrew, from Kinipple's designs, and has been working successfully since December last. The Greenock has 1,000 tons carrying capacity, dredges at the rate of 200 tons per hour, and steams when fully loaded to the place of deposit (seven miles distant) and returns within two hours.

The cost of dredging by the hopper dredger Greenock is only 3d. per ton, which compared with the stationary dredger and attendant hopper owned by the Greenock Harbor Trustees is only about one-half, the latter costing 7d. per ton.—*The Engineer.*

VALVES FOR GAS AND OTHER PURPOSES.

MESSRS. MANN and Owen's improved gas-valve is represented in the subjoined woodcuts. Fig. 25 is a sectional view; fig. 26, an elevation; and fig 27, a plan. The valve can, of course, be made to open either upwards or downwards; the latter form is shown in the engravings.

This valve is so constructed that the surfaces of the slide and those of the body of the valve are not in contact during the operation of opening and closing; but as soon as the slide is shut down, which is accomplished either by a screw and nut, or a rack and pinion, a cam, shown in fig. 28, connected with the spindle, comes into action, and bearing against a plane cast on the back of the slide, forces the latter tightly against the face. In the act of opening, a turn of the screw or the pinion-spindle releases the pressure, when the only force required to open the slide is that due to its own weight.

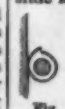


Fig. 28.

The advantages offered by this form of construction will be apparent. The surfaces are not subject to wear and tear from friction, so that no irregularities can be produced thereon by the working, and the pressure brought to bear on the slide by means of the cam is such as to ensure absolute tightness. This valve is especially suitable for use on purifier connections, where each valve, when shut, has crude gas on one side, and purified gas on the other. A slight spring is attached to the valve, which scrapes the surface from any deposit every time it is operated. Fig. 29 is an enlarged view of the index-plate secured to the top, on which a pointer, actuated by the spindle, shows the position of the slide.

Chapman's (American) gas-valve, figures 30 and 31, is of very superior construction, the seats being made of an alloy similar to Babbitt metal, which is not affected by corrosion under any circumstances. From the formation of the gate and seat, it is not liable to set fast, while it may be relied on to shut tight at all times.

The gas-valves made by Messrs. Simpson and Co. are shown in figures 32 to 35. This firm are, perhaps, the oldest makers of this class of work in London. Their valves have a wide reputation, being well known for the strength and simplicity of their design. Figures 32 and 33 show their original pattern of valve, made either with socket and spigot, or with flanges. Figures 34 and 35 exhibit one of a new design. This opens from the top downwards, the slide fitting against the face all the way. On the valve seat is a wedge, which, entering into a socket at the bottom, keeps the slide tight up to the face, independently of the pressure exerted by the spring.—*Journal of Gas Lighting.*

[AMERICAN ARCHITECT]

CAST-IRON FRONTS AND THEIR DECORATION.

IT is quite natural that we should feel a strong predilection for those time-honored materials, stone, wood, clay, which have served mankind so well since the beginning of the world—materials which have formed all the great styles of architecture now known to us. Yet, though necessarily sharing this feeling with the rest, I believe that, if allowed to become too predominate, it will stand in the way of our availing ourselves of the resources at our command, and thereby retard the healthy development of a better style of architecture. I believe that it is a sentiment which, together with our inartistic treatment of cast-iron, has given rise to remarks against the material, often so ill-placed and unjust

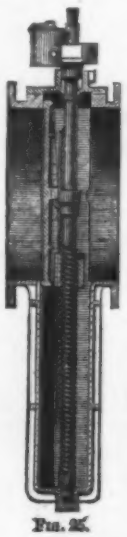


Fig. 25.

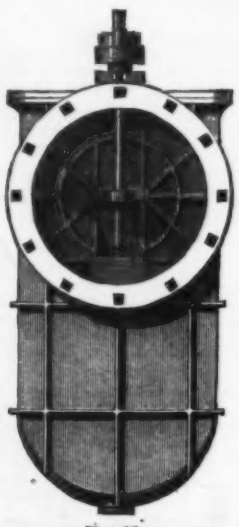


Fig. 26.

Fig. 27.

Fig. 29.

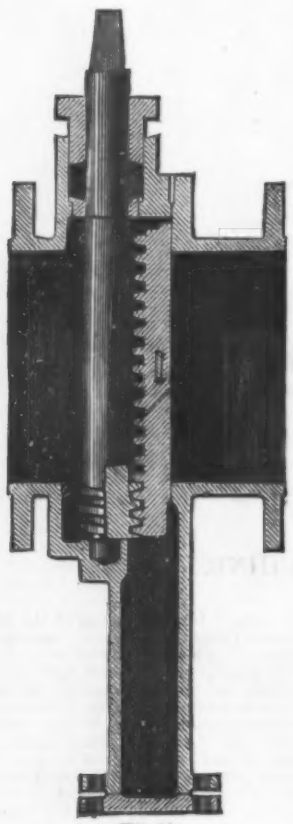


Fig. 24.

Fig. 30.

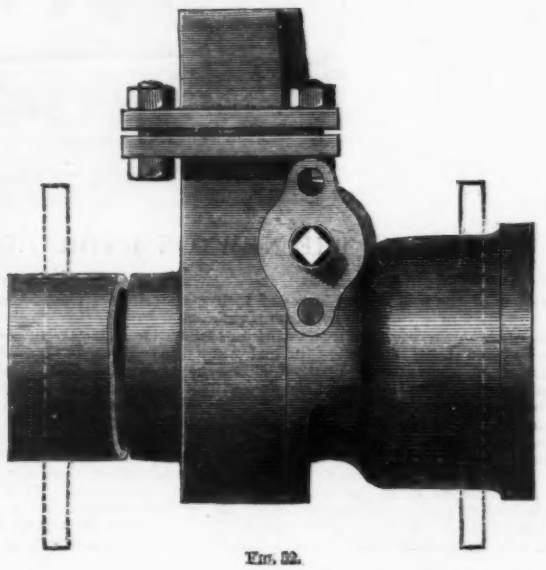


Fig. 32.

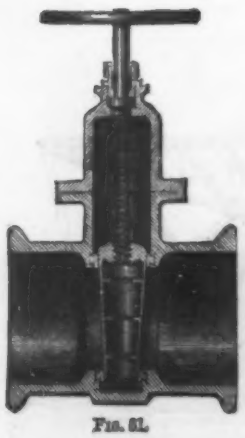


Fig. 31.

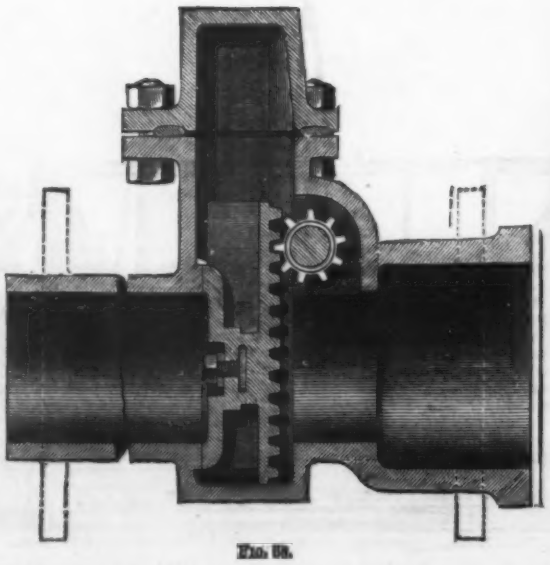


Fig. 33.

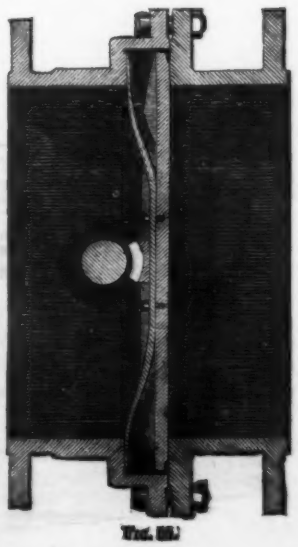


Fig. 35.

VALVES FOR GAS AND OTHER PURPOSES.

as to have produced a general misconception of its capabilities. To devote, therefore, a few words to the attempt of removing this misconception where it exists, seems reasonable and right.

If in the treatment of our iron fronts, we have so far failed artistically, this does not in the least affect the question of the adaptability of cast-iron for exterior use in building. If its use is found to be economical, its proper artistic treatment must follow sooner or later.

The value of any building material must be determined by studying either its popularity as shown by the extent of its use, or its capabilities as compared with those of others in use. In the present case our experience has been so short that it is hardly fair to form our estimate from its popularity. Yet, so far as we can learn, the verdict is decidedly in its favor.

The use of cast-iron in the manufactures does not appear to date back beyond the invention of gunpowder and the consequent casting of cannon in 1327.

The first instance on record of its successful application for building purposes was in the beams of a cotton mill in Manchester, England, in 1801, or within the lifetime of many of our friends.

For exteriors, its use is in its infancy. The first iron front erected in America is said to be that on the corner of Duane and Centre streets, New York, built in 1847.

What has been accomplished since that time by us Americans does not seem sufficient to justify any very wild enthusiasm on the part of the artistic world. Indeed, our typical iron front is the embodiment of all that is vulgar in American architecture, so that the very name has to many of us become offensive.

I believe the cause of this to be that the material is new, and that we therefore have no models to copy. The problem before us then is nothing more nor less than the invention of a new style of architecture.

Its difficulty however does not appear to have troubled the Yankee builder. "What has he to do with the knotty problems of art?" he says, and proceeds to turn out expensive imitations of stonework, in such numbers that if those in New York alone were ranged in a straight line side by side they would reach from the City Hall to Union Square, or a distance of over two miles.

That this imitation involves great waste is overlooked by the owner, who is satisfied if he gets, for comparatively little money, the appearance of stone without its substance. But it is evident that when the forms of one material are imitated in another totally different in its nature, either a loss of strength or a waste of material is the inevitable result.

The spread of iron fronts within the last fifteen years, notwithstanding the prejudice against them caused by their unhappy treatment in design, has been astonishing; and their power of resisting fire and climatic influence has commended itself to all.

One of the surest indications of the popularity of the iron front is the fact, stated on good authority, that after the great Chicago fire, every owner of iron stores who was burnt out—the iron fronts, where injured, being thrown down by the falling of adjoining walls rather than by the fire itself—rebuilt in the same manner.

Comparing next the material itself with others, we are obliged to admit that cast-iron occupies in many respects a place inferior to none.

Its *strength* is greater than that of any other material used in building. The tensile strength of the best cast-iron is stated as over 11 tons to the square inch of section, its crushing strength as over 70 tons to the square inch, or 20 or 30 times as great as that of ordinary building stones. It is calculated that a cast-iron column may be ten miles high before it will crush itself by its own weight.

Its *durability* depends upon the care with which it is kept; but painted once in three or four years, it is apparently indestructible, while stone blackens and decomposes in the air. It is said that rain-water, after washing a marble front, will be found by chemical analysis to be so fully impregnated with carbonate of lime, as to be useless for the purposes to which soft water is applied.

Its *economy* in mercantile buildings is proverbial. Mr. Fryer in his practical work for iron-workers says, "The interest on the difference in the first cost between a stone and an iron front will easily pay for one coat of paint a year." Yet once well painted and boiled in oil, an iron front will sometimes look well, in places where the exposure is not trying, for ten years without a renewal of paint.

Its *incombustibility* or power of resisting fire is, especially when backed up with brick-work, greater than that of any other known material or combination of materials unless we except terra-cotta.

Experience in the two most important fires we have known within the last fifteen years, fires in which iron fronts were fairly tested, forces us to this conclusion. Brick-work used alone will crumble or be beaten to pieces by falling walls; but protected by a solid boxing of iron, as in piers, it is practically indestructible. A most striking instance of this was shown after the great Boston fire. Wandering about the ruins on Federal Street I came to the spot where the store of Huzzey, Wells & Co. had stood. The piers of the first story were of iron backed with brick-work. It was these that attracted me to the spot. All around them for a great distance the destruction was absolute. The force of the fire seemed to have been in this neighborhood particularly terrible. Everything seemed to be reduced to powder and levelled to the ground. Granite was split up in fine pieces, and bricks literally crushed to atoms. But in the centre of all this desolation stood these iron piers uninjured. They were hurled off of their foundations, it is true, by the falling walls; but their edges were quite straight and sharp, and their condition nearly perfect. The iron had held the brick-work in its place, and reciprocally the brick-work had cooled the iron, and prevented it from twisting.

The *lightness* of iron is, in consequence of its strength, superior to that of any other material excepting wood; and in many cases, even wood itself cannot compete with it.

A notable instance of this is the cast-iron spire of the Rouen Cathedral. This spire was designed to take the place of the wooden one destroyed by fire. Though its dimensions were greater than its wooden predecessor, its comparative weight, as I was informed by the supervising architect, was estimated at only one-half.

As for the *beauty* of cast-iron, its natural unpainted surface is never supposed to be visible. Painted, it is equal to painted wood, or even, for that matter, to Pentelican marble itself when treated with color, as your interesting articles on Greek polychromy show us to have been customary with the ancient Greeks. Those masters of art were then so fond of their richly painted exteriors, that they sacrificed for color even the beautiful surface of their finest marble. We, too, might see beauty in a painted front if we could but handle our paint as it was handled by the Greeks, and had not lost all true taste and feeling for strong color.

If then cast-iron possesses, in a high degree, these essential qualities, we have done it injustice, and somewhat blindly discouraged any attempt to improve its condition. At all events it cannot be denied that much abuse has been heaped upon it, having for its only ground that very abuse itself which it has suffered from our handling. Treat it artistically, and perhaps we shall find the chief reasons for abuse will be removed.

The facility with which scroll-work can be multiplied in cast-iron, though one of its chief merits, has proved under our treatment to be one of the principal causes of its ill success. I do not refer to the repetition of forms necessitated by the construction, as, for instance, the main lines of the brackets used to support a cornice—these having similar functions should receive similar treatment—but to the unnecessary and meaningless scrolls applied for ornament and to the reduplication of casts of the same *work of art* wherever applied. A work of art repeated without variation, simply because the process of reduplication is cheap, fails at once to produce the desired admiration, both because the motive is evident and because the very object of the work of art is lost sight of or ignored. The repetition of the same story or idea beyond certain limits, however good that story may be does not increase its use or interest, but rather indicates the weakness of the author.

Where the ornament is of such a kind that it can be formed naturally of cast-iron or of wrought-iron as it was treated by the Gothic architects, its effect used with discretion must be pleasing. As an illustration, the foliated capital of a column treated like a stone-carving would produce a heavy and awkward appearance, because iron cannot be undercut like stone, but must be drawn from a mould. But unlike stone the far more effective treatment of overlaying is open to the iron-worker; and lightness and strength of shadow corresponding to the general character of iron-work may be obtained in a legitimate manner. Such foliations may be treated far more boldly in iron than in either stone or wood, on account of the freedom of the former from liability to crack under the influence of the weather.

Cast-iron partaking more of the character of wood than of stone, iron architecture should more nearly resemble wood-work than masonry. The projection of cornice, caps, and hoods may be carried out to any desired extent for the purpose of shading the front and protecting the paint.

Where, however, sculptured panel-work is required to any great extent, it would be well to combine with the iron some material adapted to receive chiselled work.

Although up to this time, no attempt has been made to combine in this way, for ornament, other materials with iron, I nevertheless believe that very beautiful effects might thereby be produced.

Terra-cotta is a material which in many respects resembles iron, and might be combined with it in the form of sculptured panels with the most brilliant effect. Colored in its manufacture to any shade desired, in such a manner as to rival the beauty of the richest stones, it could be made to harmonize with the coloring of the iron-work; and its presence would relieve the eye from the monotonous nature of the surface of paint.

Terra-cotta may be carved like stone. It is a mistake to suppose that, because it is a plastic material, everything done in it must be cast from the mould, and bear the character, marks, and monotony of the mould. There is no more necessity for using moulds for terra-cotta than for reduplicating ornaments of stone. Moreover, the material actually built in is the same that came direct from the hands of the artist, and not, like stone-carving, frequently only a copy of his clay model. The work is touched up and chiselled by the artist himself when partly hardened before it is baked, so that when finished it retains forever the character and sharp impress of his tool. Thus a work of art in terra-cotta combines the advantages of the freshness and vigor of the clay model and the beauty and durability of the stone. It gives too, like iron, an opportunity for brilliant effects of light and shade by the application of separately modelled pieces of material superimposed over the recessed parts while all are soft, and then the whole being burnt together into one homogeneous mass. By this means the economy in proportion to the effect produced is great.

In its power of resisting fire, its immense strength, its mode of manufacture, and its durability, terra-cotta again resembles iron. It is, in fact, imperishable, and in its artistic effects unchanging. In its iron frame it would stand firm long after the surrounding stonework had blackened or crumbled into dust.

We must recollect that in our iron fronts that which appears on the surface to be a series of independent columns, one above the other, and separated by their respective entablatures, is in reality, behind the deceptive veneering of "the orders" applied to the exterior for ornament, only a single column running up through all the stories from basement to roof. All the rest of the front is bolted or hangs, as it were, to these upright pillars. No heavy horizontal courses are necessary as in other kinds of structures, because here the interior construction rests on the side or party walls. Only light screen or panel work unites the uprights. Hence their continuity is unbroken; while with masonry, on the contrary, the pillars between each tier of window opening must support the heavy horizontal blocks which crown these openings. While iron-work is perpendicular, and secured by bolts, masonry is laid in horizontal courses, and its principle of immovability, or resistance against overthrow, is in its gravity. The principles of construction being directly opposite, the form must of course also be different; and what is appropriate and beautiful for the one material is false and ugly for the other. The iron front, then, consists practically of a row of hollow columns rising uninterruptedly above each other from basement to the roof. Everything else is bolted to these; and the bolt-heads should, where possible, be treated ornamentally. Consequently it is not only a legitimate and truthful method of designing an iron front, but the only one in accordance with its actual construction, to run the piers boldly up through all the stories from bottom to top, and to represent all that lies between the piers as bolted or hung, with or without the aid of brackets, to their sides. The system generally adopted is quite different from this. Two or three hundred capitals and bases, usually all exactly alike, with their respective architraves, friezes, and cornices, corresponding more or less with the various floor levels, are sprinkled over the front without any meaning or object other than that of imitating some equally monotonous building in stone.

The Grecian "orders" should never be represented in iron architecture except in buildings of a single story in height.

With stone-work it is different. Where the "orders" are used, it is utterly false in design to run columns through two or more stories; because the entablature, which represents the floor supports, cannot be bolted, as in iron-work, to the side of a continuous pier, but must rest immediately upon a separate pillar of its own. Thus at each story where there is an architrave there should also be a column with its capital and base to support it, and complete "the order." The Greeks, with their delicate and refined taste, invented the capital to express by some art form the conflict between the column and its architrave—that is, the conflict between the downward pressure exerted by the architrave upon the column, and the resistance to that pressure on the part of the latter. The art form chosen was the bent leaf; and this sculptured on the shaft at the point of conflict, or contract with the architrave, gave rise to the famous Greek capitals, so often copied but so seldom understood. This may now be considered as an established fact, and disproves the various absurd theories published in popular histories of architecture in regard to the origin of the Greek capitals—as, for example, that based upon the story of the basket of a Corinthian virgin placed upon an acanthus-plant suggesting to Callimachus the Corinthian capital. If I may be permitted to add anything to your letters above referred to on the coloring of this ancient architecture, I would say that according to Carl Boetticher, Professor of Greek Architecture at the Royal Academy of Berlin, an able and active student of the exhumed ruins of their temples, Doric capitals have been discovered clearly sculptured and painted with the leaves bent as above described. In order to distinguish the heavier from the lighter orders, the leaves in the capitals were represented as more or less strongly bent. Thus in the Doric, or heaviest of the orders, the point of the leaf was doubled entirely over until it touched its base, indicating that a prodigious weight was borne; whereas in the Corinthian, or lightest of the orders, the ends of the leaves are but slightly curved, and convey the idea of grace and lightness. This acceptation explains satisfactorily what otherwise would seem an unaccountable tautology in the multiplied repetition of the same form of floral decoration in a single building of the Corinthian order.

In the Gothic architecture no such art form was required, as there was no conflict to express. The Gothic capital had a totally different origin and meaning. It merely marked the springing of an arch from a pier, and hence could be treated far more freely.

Following the same principle in the iron building in question, no capital at all has been represented on the piers running through the second and third stories. Merely a rosette or ornamental bolt-head in a square panel marks the springing of the arch from the tops of the piers, for these arches are actually bolted to the piers.

The building being backed up with brick, our problem becomes more complicated, and the design more difficult; for in it must be reflected the presence of the brick-work. Hence a somewhat heavier appearance has been given to the building than would have been necessary for iron alone. Hence the form of the first story, and the heavy arches above the third. This brick-work serves not only to protect the iron in case of fire, but also to equalize the temperature of the building in winter and summer. It serves also to keep the interior of the iron-work dry by preventing the possible congelation of water in the atmosphere upon the inner surface.

In masonry, when no orders are used, a portion of the piers may often be carried up through several stories without impropriety; for they act merely as buttresses to strengthen the walls where they are most in need of strength. If arches be thrown from pier to pier at the top of the building, still no fault can be found with the design, because it is truthful to the construction. Objection has been made to the arches in this building, on the ground that they are stone forms and inappropriate to iron. It is easy to show the incorrectness of this criticism. The iron arch, far from being a copy of the stone arch, is, on the contrary, the only one which is perfect and in every respect unobjectionable. The arch of masonry is to such a degree objectionable on account of the lateral thrust, that the Greeks never trusted it. In the quaint language of architects of India, "the arch never sleeps," but is always at work trying to tear the building to pieces. The iron arch, being formed of a single piece, is in a great measure free from this objection, while it contains that element of strength which its approach to the parabolic form gives to the arch in general.

These arches are ornamented with the moulding vulgarly called "the egg and arrow ornament." This ornament is of Greek origin, and is another art form used by them to express the conflict, explained above, between two members of the architecture. It is a conventional representation of a double row of leaves bending under some superincumbent weight. The Romans copied this moulding, and called it "the egg and arrow ornament," which illustrates well their total inability to appreciate the spirit and beauty of Greek art; for, of all things in the world, what more unfortunate choice could have been made to place between two heavy pieces of masonry than eggs and arrows?

With regard to the rest of the decoration, care has been taken that no ornament should in any case be applied without its *raison d'être;* and nowhere, except in panel-work, has any ornament been employed where the members of construction did not demand some art form to express their functions. For the purpose of heightening the metallic character of the building, it has been painted a light bronze-green color enlivened on the projecting parts with gold, and in the recesses with Indian red.

But without going further into details, I will only add that, as no national style is possible unless we make the best use of the materials at our command, and refuse to reject any one of them until we have first proved it to be unmanageable; and as ample light and air space, economy, and non-combustibility are the chief desideratum of mercantile buildings in America—iron should not be too summarily disposed of for building purposes, for it may be found that it contains for the satisfaction of the above desiderata, valuable qualities which no other material possesses in an equal degree.

JOHN PICKERING PUTNAM.

A LARGE TANK.—At Kanthalai, Ceylon, there is a magnificent tank on a scale so enormous that it would now cost more than five million dollars to erect it. It was constructed about A.D. 275. Still more remarkable is the great store tank of Kalowewa. Its circumference is supposed to have been hardly less than thirty miles, and it was kept full by two rivers. Channels extended from it over fifty miles, which conveyed an unfailing supply of water to certain large store tanks and thence to minor village tanks. The Ceylon Government proposes to gradually restore many of these great works. Here we see how the ancients prevented famines.

THE PARIS EXHIBITION.

THE history of this enterprize is as follows:—The Commissioner-General, M. Krantz, issued a report in May, 1877. The Commissioner first analyzes general arrangements, then special facts relating to the works, the relations with foreign countries, and lastly the organization of the French portion of the Exhibition.

The decrees authorizing the construction of the Paris Exhibition bear the dates of the 4th and 13th of April, 1876. A preliminary Commission was first formed to study the question of the site, and to determine the most suitable form of construction for the buildings. About the same time the various foreign Governments received an official notification of the intention to hold the Exhibition, and were invited to take part in it. The Chambers approved of the financial scheme of the undertaking, and the law bearing on this part of the question was passed on the 29th of July, 1876. The State by this law takes all risks, and reserves the direction of the Exhibition, without any interference however with private interests. The city of Paris makes a contribution which was fixed at £240,000.

M. Krantz was appointed to the post of director on the 5th August, 1876, and he immediately organized the various executive departments, comprising the execution of works, of technical services, of foreign commissions, and the French industrial, the fine arts, the agricultural, horticultural, and piscicultural sections. The names of the chief officers controlling these sections we have already published (see page 252 *ante*.) The time available being very short, the time accorded for settling preliminaries was far less in the case of the present Exhibition than it was for that of 1867, which was decided on as early as June 22, 1863. Whilst the Direction of Works devoted its attention to inspecting and reporting on the Champ de Mars and the Trocadéro, and considering the various offers of contractors, the General Commission prepared the preliminary scheme. The experience gained in 1867 was found of great assistance in completing this task. We may indicate briefly the leading conditions by which the Commission has been governed. In each section devoted to exhibitors of the same country, the objects shown will be divided between the following groups: 1. Works of art. 2. Education, instruction, materials, and processes connected with the liberal arts. 3. Furniture and its accessories. 4. Textile fabrics, clothing and accessories. 5. Chemical industries, raw and manufactured material. 6. Machinery and processes of mechanical industries. 7. Food products. 8. Agricultural. 9. Pisciculture. Each of these groups is divided into classes according to the system we shall hereafter describe. No person will be allowed to copy any work of art or other exhibit shown in the palace or grounds without the consent of the exhibitor. Under the conditions of the law of May 28, 1868, relative to the guarantee of inventions which may be patented, or of designs which may be otherwise secured to the originator, the exhibitors will enjoy all the rights and immunities accorded by this law, under the following paragraph: "Any Frenchman or foreigner, proprietor either of a discovery or an invention which may be patented under the terms of the law of July 5, 1844, or any design which may be protected under the law of March 18, 1806, can, if such object be admitted into any public exhibition and authorized by the Government, obtain from the préfet or sous-préfet of the department or arrondissement in which this Exhibition is held, a certificate relative to the object exhibited. This certificate assures to the holder the same rights which letters patent would confer on him, or which would be secured by a registry of design, and dating from the admission of the exhibit to three months after the closing of the Exhibition, without prejudice to the patent which the exhibitor may then take."

French and foreign exhibitors will have to pay no rent for the space accorded to them. The floor is provided in good condition throughout the buildings of the Champ de Mars, excepting in Machinery Hall; any modification or alteration will only be allowed by the consent of the Commissioner-General, and at the cost of the exhibitors. These latter will also have to bear other expenses of installation and decoration in the palace, the parks, and the gardens. Such expenses will essentially comprise the providing and establishment of cases and draperies in the buildings, special earthworks and plantations in the park, and around annexes authorized by the Commissioner-General. The works of French and foreign artists executed since the 1st of May, 1867, will be eligible for admission. These works will be comprised under the seven following heads: 1. Paintings. 2. Water colors, enamels, painting on porcelain, etc., but excluding all works of art referring only to ornamentation. 3. Sculpture. 4. Fine medal engravings. 5. Architecture. 6. Engravings. 7. Lithography. The following are excluded from this group: Copies, even such as reproduce the original in a different method or manner. 2. Unframed pictures or drawings. 3. Work in terra-cotta.

All products of agricultural industry are admissible, except explosive or other dangerously inflammable products. Alcohols, hydrocarbons, or other inflammable or explosive liquids will be received only in strong vessels, the forms and dimensions of which are prescribed, and the same restriction applies to chemical products, which might injure adjacent exhibits, or incommode or endanger visitors. Fuses, fireworks, chemical matches, and similar objects, will only be received without any addition of inflammable material, or as imitations.

Water, gas, and steam for the Machinery Halls will be supplied gratuitously, but all countershafting, intermediate gearing, and belting, will have to be supplied by the exhibitors. Active measures will be taken to protect all exhibits against injury, but the Government will in no case be responsible for accidents or damage by fire or other cause which such exhibits may incur; exhibitors will, however, have all facilities to insure their goods against risk.

A general supervision and inspection of the building will be at the charge of the French authorities, but every foreign commission will have to provide for the special guardianship of their respective sections, and the officials selected by them for this work must be approved by the Commissioner-General. Such officials will have a special uniform or distinctive badges, and they will be empowered under all circumstances to call for the co-operation of the French agents and police in the building. In the French section, the exhibitors will combine to form a separate police system, independent of the general surveillance established by the General Commission. The different members of this force will have to be approved by the Commission.

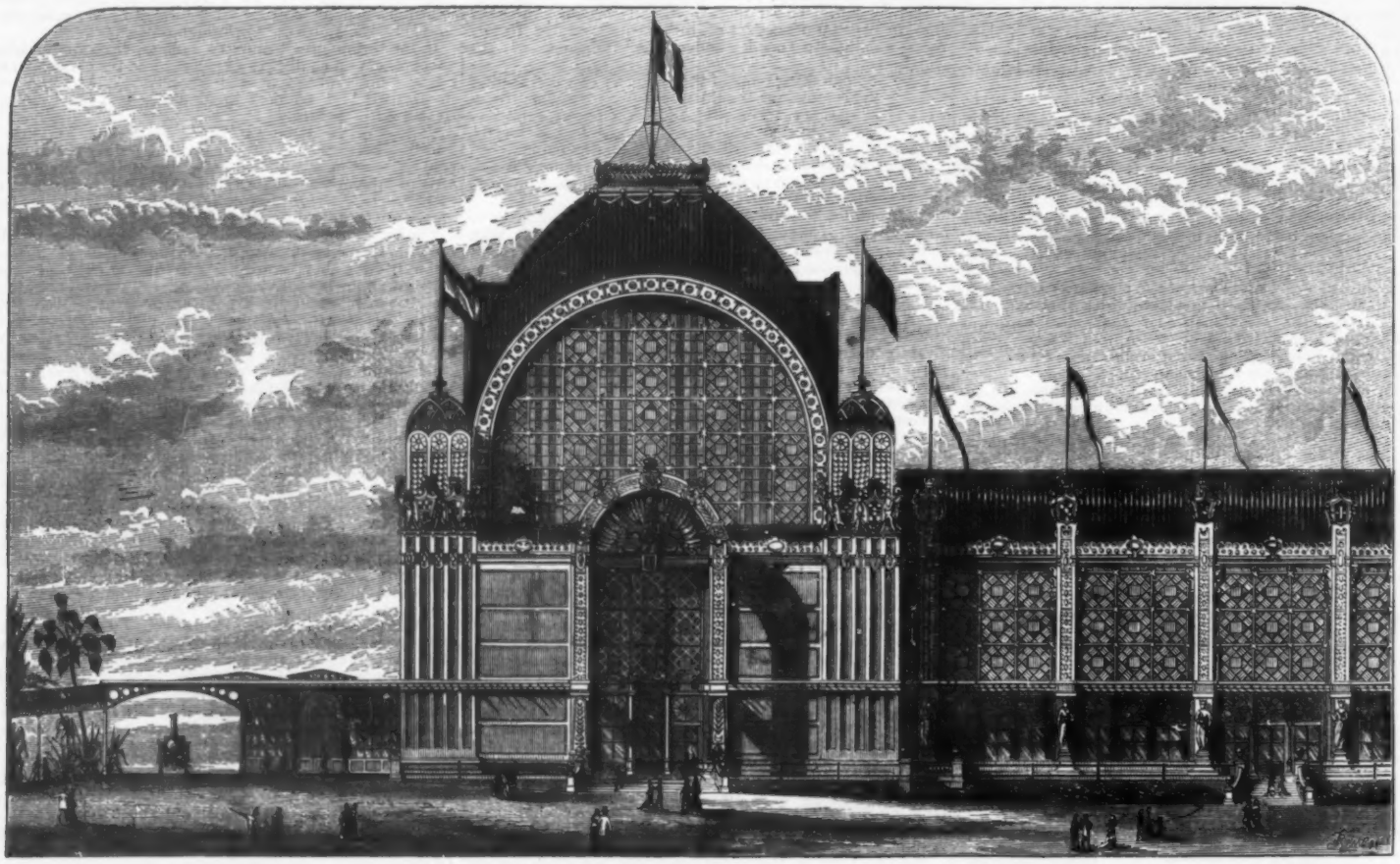
On the 13th of September, 1876, the special instructions relative to the transmission, reception, installation, and returning of goods were issued. According to these instructions French packages enclosing objects for exhibition must each carry the letters E. U. enclosed in a circle, and, besides, the key number of the exhibitor. On the invoice accompanying the package will be repeated, besides the name of the exhibitor, the same number and distinctive letters. The sender will also attach on two sides of the package the printed address sent to him in duplicate by the Committee of Admission. Every exhibitor must attend, either by himself or by his agent, to the transmission and reception of the cases, as well as to the inspection of their contents. If the exhibitor or his agents are not present to receive the packages on their arrival at the gate of the Exhibition, the carrier will be called upon to take them back at once. The General Commission will abstain from any intervention between the carriers and the exhibitors. It will, however, apprise the latter of the general agency which will be established by the Paris Chamber of Commerce for the reception, retention, and re-expedition of the articles exhibited by citizens of foreign countries.

Foreign cases containing exhibits will also bear the letters E. U. enclosed in a circle. They will be addressed to the care of the Commission appointed by the country whence the goods are forwarded. Such cases must also carry on their sides indications of their nationality, that is to say, the emblems of their respective sections. Exhibits, French as well as foreign, will be admitted within the Exhibition from 1st of January to the 30th of March, 1878. This latter date may be extended, by special permission of the General Commission, for objects difficult of transport, or of a special value or character. The Exhibition will form actually a bonded warehouse, and all foreign exhibits may be received as bonded goods up the 15th of March, 1878, by all common or international transport agencies. Exhibits of all classes must be installed, and arrangements completely terminated, by the 15th of April, 1878, this date admitting of no extension. Consequently the General Commission reserves to itself the right of disposing of all space which at the above date is not occupied, or is only partially occupied, by the exhibitors to whom it has been assigned. The General Commission will not interest itself with the storing or preservation of empty cases; it does not even offer any facilities for this purpose, nor does it reserve any space. It only recommends exhibitors, who themselves are not in a position to provide for their empty cases, to address themselves to the general agency established by the Paris Chamber of Commerce.

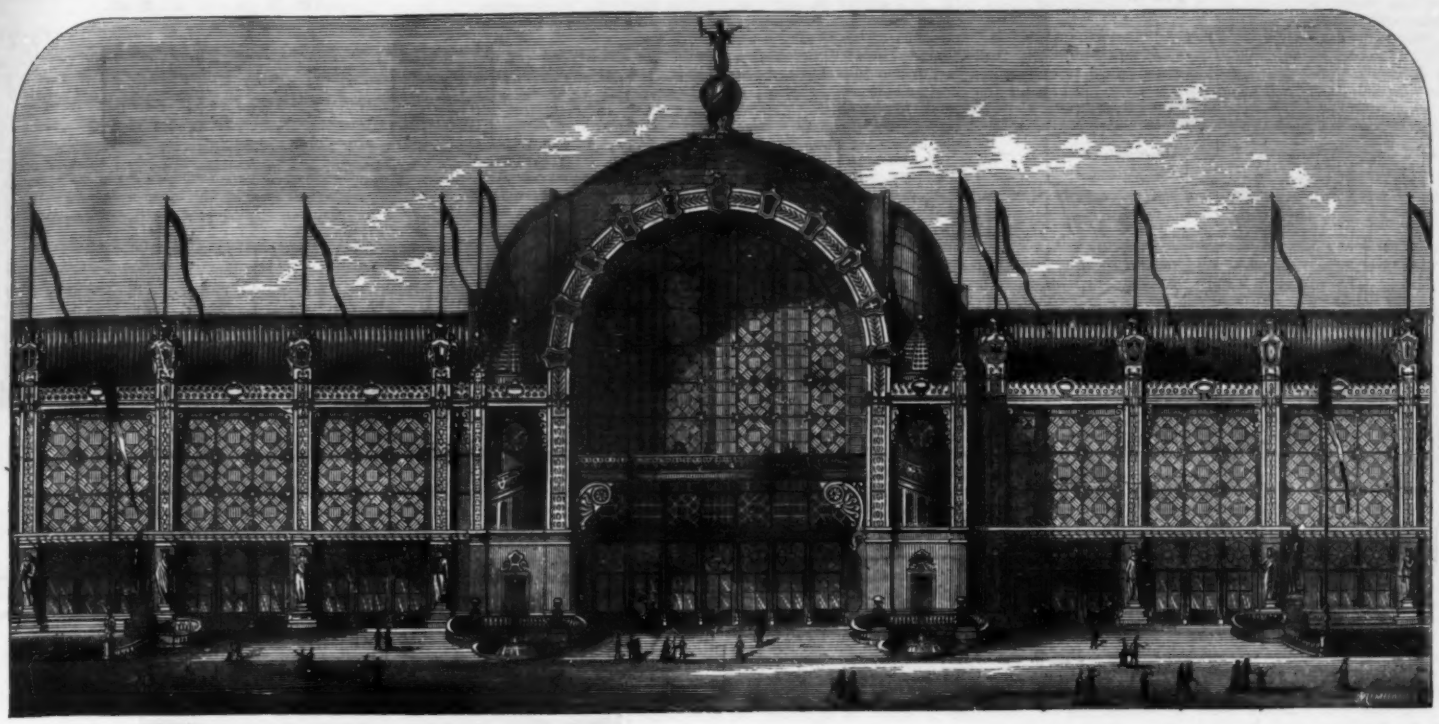
Immediately after the closing of the Exhibition, the exhibitors must proceed to remove their goods and show-cases, a work which must be ended before the 15th of December, 1878. Beyond this time, goods, and packing and show-cases which have not been removed by the exhibitors or their agents, will be placed by the authorities in a public depôt at the cost and risk of the exhibitors. Any objects which on the 30th of June, 1879, shall not have been removed from this depot will be sold publicly, and the funds resulting will be devoted to charitable purposes.

From the foregoing resolutions it will be gathered that the French General Commission leaves more than might be desired on the exhibitors, who, under the unusual conditions which take them out of the regular routine of their business, and having new and considerable duties forced upon them by the very fact of participating in the Exhibition, should certainly be relieved of as much trouble as possible. The fact that the General Commission undertakes to make no provision for empty packing-cases, and by inference throws all the responsibility of unpacking and removing cases to such depots as may be found (unless the exhibitor places himself in the hands of the agency established by the Paris Chamber of Commerce), as well as of bringing back these cases at the close of the Exhibition, will not only involve the exhibitors in a great amount of extra work and expense, but is likely also to be highly conducive to confusion and delay.

For the benefit of those very numerous manufacturers in this country who are going to take part in the Exhibition next year, we would point out that, thanks to the admirable arrangements made by the British Commission, no such delay, annoyance, or trouble will devolve upon them, and we would advise such exhibitors to rely upon these arrangements and themselves instead of trusting to any agents who may press forward their services. Such agents, however laudable their motives, will, exhibitors may rest assured, render them but little if any service, and must involve them in needless expense. We advise them, therefore, most strongly to have business relations only with the British Commission at Westminster, or with such persons as the Commission may recommend. We make this remark solely for the benefit of exhibitors, and in justice to the British Commission, whose arrangements are so perfect that the



THE PARIS UNIVERSAL EXHIBITION OF 1878. ENTRANCE TO MAIN VESTIBULE.



THE PARIS UNIVERSAL EXHIBITION OF 1878. CENTRAL ENTRANCE TO MAIN VESTIBULE.

expense and trouble of securing agents are rendered entirely unnecessary.

We may briefly glance at the financial department of the Exhibition, divided into two bureaux, both intending to carry out the law of July 29, 1876. This law was silent on the total amount of credit to be voted for the Exhibition. The approbationary decree of the financial arrangements was due to the demand of the General Commission to limit this credit to the sum of £1,412,520, and stipulated that if this sum, which was the amount of the estimate submitted to the Chambers, were exceeded, a new law would be necessary. On page 123 of vol. xxii. we indicated the general divisions of this credit, but we now republish this in summary.

	£
General service	160,520
Works and installation on the left bank of the Seine	874,000
Works and installation on the right bank	338,000
Unforeseen expenses	40,000
Total	1,412,520

The following Table contains a *résumé* of the work necessary for the construction and completion of the two buildings and their surroundings.

Nature of Work.	Champ de Mars.	Trocadéro.	Total.
Earthwork:			
Filling, cubic yards	647,000	184,000	831,000
Excavation "	368,000	131,000	499,000
Extra earthwork, cubic yards.	278,000	53,000	331,000
Masonry:			
Stonework for buildings, cubic yards	135,400	123,900	259,300
Stonework for sewers, aqueducts, etc., cubic yards	19,500	2,000	21,500
Ironwork:			
Wrought iron, tons	21,500	1,960	23,460
Cast iron, tons	6,135	60	6,195
Timber, Glass, and Roofing:			
Woodwork in framing, cubic feet	91,900	10,600	102,500
Flooring, square feet	1,985,000	215,000	2,150,000
Roofing, square feet	1,741,000	150,000	1,891,000
Glass	1,286,500	64,500	1,351,000
Other Works:			
Water pipes, feet run	49,200	28,500	77,700
Railway, feet run	35,400	2,300	37,300

The above *résumé* does not include the installation works necessary in the gardens on the Quai d'Orsay, and the slopes of the Seine.—*Engineering.*

THE STRENGTH OF GUN METAL.

Results of a Series of Experiments made in Portsmouth Dockyard with the View of Ascertaining what Loss of Strength and Ductility takes place in Gun Metal Compositions when raised to high Temperatures.—The object of making these experiments was to see whether gun metal would be more or less suitable than cast iron for making such articles as stop and safety-valve boxes, steam pipe connections, fastenings, etc., which might be subjected to high temperatures, either from superheated steam, or from being placed in proximity to hot uptakes or funnels.

The results of these experiments show that it is desirable to make further investigations on this important subject.

Tenacity of Metals at various Temperatures.—The method adopted for heating the specimens was an oil bath, near the machine for breaking them; the specimens were suspended in the oil out of contact with the vessel containing it, and the dies for gripping them were also so heated; the process of fixing and breaking occupied about one minute, during which care was taken to prevent, as far as possible, loss of heat by radiation and conduction.

The recorded temperatures are those of the oil when the specimens were taken out.

In the case of gun metal three or more tests were made at each temperature, and the results recorded in the table are the mean, except in a few cases affected by defects in the metal.

All the specimens of each composition were run from the same pot in the same manner, *i. e.*, in a horizontal position with a head of 2½ in. to secure uniformity, except those in columns 1 and 2, which were purposely cast separately. It will be observed that those in No. 2 were stronger at the atmospheric temperature than No. 1, and that they suffer sooner by increase of temperature. It may be observed that all the varieties of gun metal suffer a gradual but not serious loss of strength and ductility up to a certain temperature, at which, within a few degrees, a great change takes place, the strength falls to about one half the original, and the ductility is wholly gone. At temperatures above this point, up to 500 deg., there is little, if any, further loss of strength; the precise temperature at which this great change and loss of strength takes place, although uniform in the specimens cast from the same pot, varies about 100 deg. in the same compositions cast at different temperatures, or with some varying conditions in the foundry process. The precise temperature at which the change took place in No. 1 series was ascertained to be about 370 deg., and in that of No. 2 a little over 250 deg. Whatever may be the cause of this important difference in the same composition, the fact stated may be taken as quite certain. The possibility of such a change taking place at a temperature so low in the best gun metal, used for the more important parts of machinery and boiler mountings, is so important that we tested the point most carefully by repeated experiments at the same temperature, both sorts being heated at the same time in the bath.

Phosphor bronze, the only metal in the series which, from its strength and hardness could be used as a substitute, was less affected by temperature, and at 500 deg. retains more than two thirds of its strength and one third its ductility; when this metal was tested we were not aware of the difference which may arise from variation in the process of casting, or difference in the quality of material used, shown in gun metal, and before adopting it as a substitute for gun metal this point should be tested for phosphor bronze; and also whether it is possible to harden any of the other compositions without loss of strength.

Rolled Muntz metal and copper are satisfactory up to 500 deg., and may be used as securing bolts with safety.

Wrought iron, Yorkshire and re-manufactured, increases in strength up to 500 deg., but lose slightly in ductility up to 300 deg., when an increase begins and contiuues up to 500 deg., where it is still less then at the ordinary temperature of the atmosphere.

In Landore steel the strength is not affected by temperature up to 500 deg., but its ductility is reduced more than one half.

A LITTLE GIANT.

A LIGHT locomotive built by Porter, Bell & Co. for the Lake George and Muskegon River Lumber Railroad in Michigan makes the following record: The road is 7½ miles long, gauge 4 ft. 8½ in., rails 25 lbs. per yard. Heaviest grade, 33 ft. per mile and 500 ft. long; sharpest curve, 300 ft. radius; there is a curve 1,900 ft. radius on the 33 ft. grade. The locomotive has 8 by 14 in. cylinders, drivers 28 in. diameter, and weighs 8½ tons. The locomotive regularly hauls trains of cars weighing 2,500 lbs. each, and carrying 12,000 lbs. each, making the total train load 217,500 lbs., at a regular speed of 11 miles an hour. On a special trial it has hauled 15 cars weighing 2,500 lbs. of 297,500 lbs. The usual number of round trips is 12 per day, a daily mileage of 180 miles.

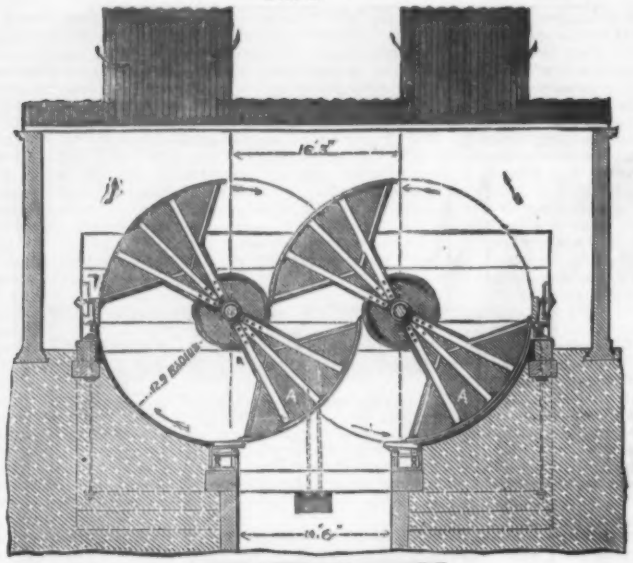
TENACITY OF VARIOUS METALS AT DIFFERENT TEMPERATURES UP TO 500 DEG. FAHR.

CONSTANT OF MACHINE 50.25.

Temperature.	Gun-Metal Rods, 1 in. Diameter. 1. Copper 87.75 Tin ... 9.75 Zinc ... 2.5		2. 2nd set. Copper 87.75 Tin ... 9.75 Zinc ... 2.5		3. Copper 91. Tin ... 7. Zinc ... 2.		4. Copper 85. Tin ... 5. Zinc ... 10.		5. Copper 83. Tin ... 2. Zinc ... 15.		6. Copper 92.5 Tin ... 5. Zinc ... 2.5		Phosphor Bronze Rods 1 in. Diameter. Copper 92.5 Tin ... 7. Phos. 5		Muntz Metal Rods ¾ in. Diam. Copper 62. Zinc ... 38.		Copper Rods ¾ in. Diam.		Cast-Iron Rods 1 in. Diameter. Welsh ... .25 Scotch ... .25 Scrap 5		Wrought Iron. Re-manufactured. Rods ¾ in. Diameter.		Yorkshire. Rods .70 in. in Diameter.		Landore Steel Strips, .14 in. by .49 in.	
	Tensile.	Ductility.	Tensile.	Ductility.	Tensile.	Ductility.	Tensile.	Ductility.	Tensile.	Ductility.	Tensile.	Ductility.	Tensile.	Ductility.	Tensile.	Ductility.	Tensile.	Ductility.	Tensile.	Ductility.	Tensile.	Ductility.	Tensile.	Ductility.	Tensile.	Ductility.
Fahr.	lb.	Per cent.*	lb.	Per cent.*	lb.	Per cent.*	lb.	Per cent.*	lb.	Per cent.*	lb.	Per cent.*	lb.	Per cent.*	lb.	Per cent.*	lb.	Per cent.*	lb.	Per cent.*	lb.	Per cent.*	lb.	Per cent.*	lb.	Per cent.*
Atmospheric deg.	535	12.5	575	8.75	525	18	525	21	455	26	560	20	609	17.5	700	2.5	480	2.5	480	Nil	500	22	460	25	553	29
100	505	10	...	...	525	15.5	550	18	483	26	...	...	614	17	680	2.5	465	2.5	428	"	530	18.75	480	24.25		
150	525	11	...	...	525	14	530	19.5	490	25.5	...	...	610	18	720	3.5	445	4	441	"	530	15				
200	493	10	535	8.75	490	9	523	19	460	26.25	440	11	605	18	685	3.5	440	5	440	"	530	15	465	17.25	535	27.5
250	503	10	535	5	255	3	515	16	440	26	360	6	588	15	670	5	430	7	470	"	540	15				
300	500	10	295	.66	265	Nil	531	13.25	435	23	255	.66	575	12	650	2.5	420	6	490	"	530	15.5	480	7.5	555	11.25
350	450	8.25	295	Nil	...	...	495	17	435	25	...	...	470	7	650	2.25	430	6	470	"	560	12.5				
400	245	.75	...	...	260	Nil	260	2	435	25	...	...	434	5	600	2.25	420	6	401	"	540	12	465	15	500	12.25
450	265	Nil	...	...	...	...	230	2	152	1.3	...	...	380	4	615	2.75	415	6	400	"	530	15				
500	250	"	...	...	275	Nil	230	2	142	Nil	...	...	430	5	620	3*	390	5	400	"	530	20	450	13.75	600	19

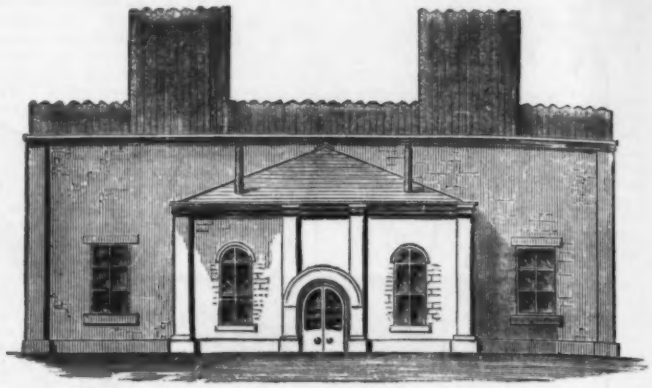
* In a length of 10 in.

FIG. 1.



CROSS SECTION OF VENTILATOR

FIG. 6.



FRONT ELEVATION OF ENGINE & VENTILATOR HOUSE

FIG. 2.

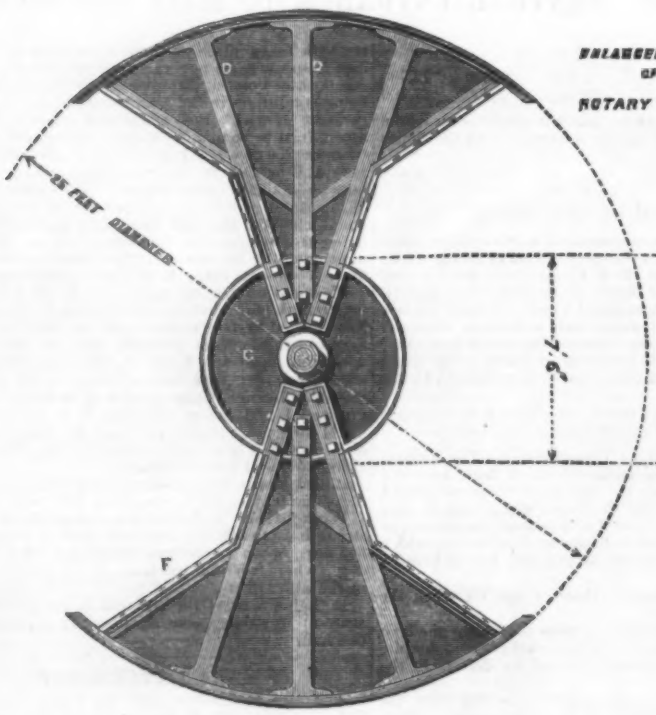


FIG. 3.

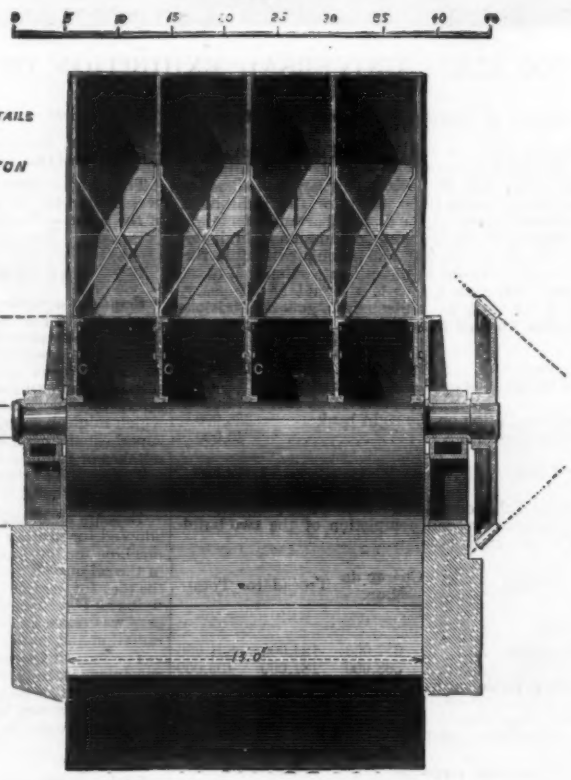
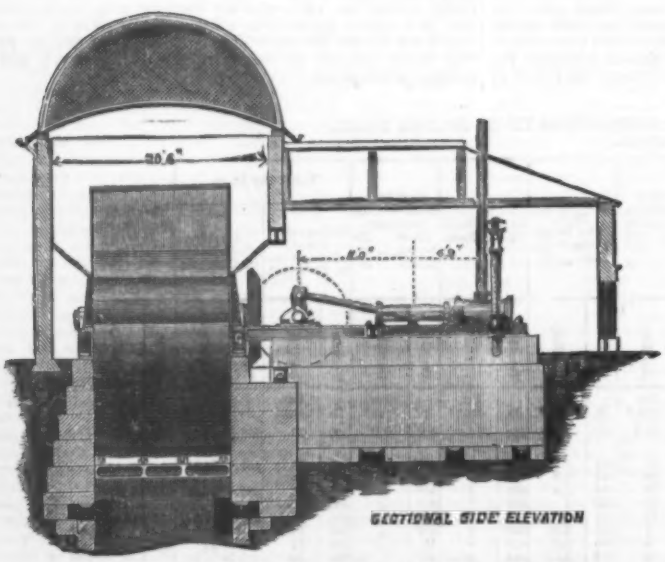


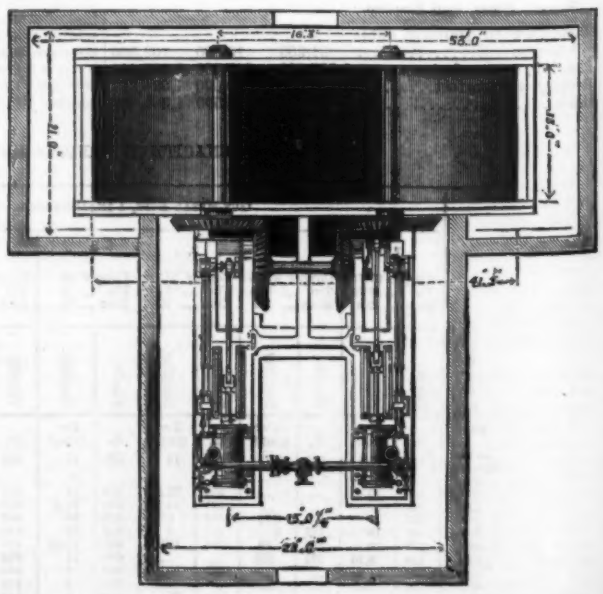
FIG. 4.



SECTIONAL SIDE ELEVATION

FIG. 5.

PLAN



THE GREAT ROOTS BLOWER.—AS USED FOR MINE VENTILATION AT THE CHILTON COLLIERY, ENG.

ROOTS' MINE VENTILATOR.*

By Mr. E. Hamer Carbutt.

The Roots' blower is a rotary air-compressing machine, as distinguished from a fan which throws the air off by centrifugal action. In principle it is analogous to a blowing cylinder, with the difference, that the air is expelled constantly in one direction and in four distinct volumes at each revolution of the blower; but with a blowing cylinder the direction of the current of air is altered at each end of the stroke.

For a long time previous to the introduction of Roots' blower into this country, it had been extensively used in America; blowers of a capacity of 100,000 cubic feet per minute had been constructed there, and one of this capacity was employed for working a pneumatic railway under Broadway, New York. The leading feature of Roots' blower consists of two duplicate rotary pistons, fixed upon separate shafts and working in a casing, which is provided with inlet and outlet openings either at the top and bottom, or at the sides, according to the position in which the machine is arranged. The rotary pistons in revolving are maintained in their proper relative positions by gearing on the shafts, and they revolve closely together, but not in actual contact with each other or with the casing.

Fig. 1.

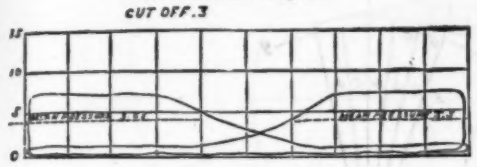


Fig. 2.

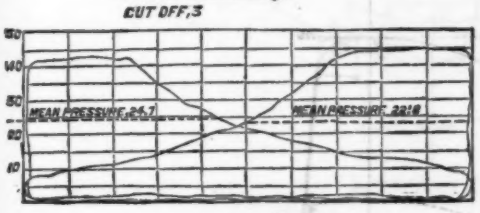
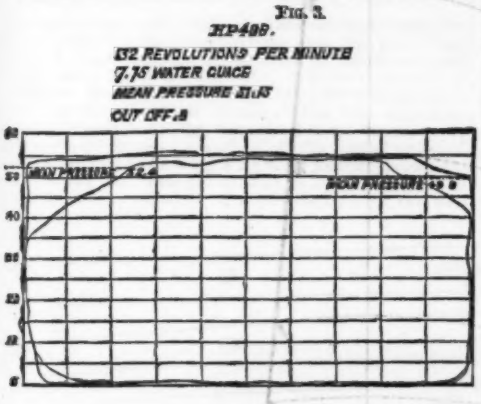


Fig. 3.



As a ventilator for mines the blower is shown in the engraving. This ventilator has been fixed at the Clinton Colliery, near Ferryhill, belonging to the South Durham Coal Company, and was started at the beginning of this year, it having been in constant work up to the present time. It consists of the two rotary pistons A A, which are each 25 ft. diameter and 13 ft. wide, and are built up upon steel shafts. Upon each of the shafts are keyed five cast iron disc plates C C, having flanges at their circumference which are all turned to exactly the same diameter. In each disc plate there are three wrought iron bars D fixed on each side of the center, and reaching to the outside of the rotary piston; planed recesses are provided in the disc plates to receive the bars, which are also secured to the disc plates by bolts turned to fit. The outer ends of the bars are widened, and marked off and slotted to the radius of the outer circle. Angle irons bent to the radius of the outer circle are riveted to the extremities of the bars, and are covered with ¼ in. sheet iron plate; the center circles are also covered with ¼ in. sheet iron plates on the turned flanges of the disc plates C C. The sides F F of the pistons are covered with wood, and the ends with sheet iron. These rotary pistons revolve in bearings fixed upon deep cast iron girders, which form the framework of the ventilator pit, and are connected together at each end of the ventilator by cross girders. The girders and the cast iron side plates above them are planed on their inside surfaces, and the stonework of the ventilator pit is dressed off level with the planed girders. The engines to drive the ventilator are a pair of 28 in. cylinders with 4 ft. stroke, and provided with adjustable cut-off valves. They are placed at right angles to the ventilator, and are connected to it with bevel wheels 9 ft. 2¼ in. diameter, two bevel wheels being fixed upon the crank shaft, each gearing into a bevel wheel keyed upon the end of the ventilator shafts. The engine beds are carried along and fixed upon a stay girder, securely keyed and bolted to the main girder G. The main girders are fixed 13 ft. ¼ in. apart, therefore the clearance between the rotary pistons of 13 ft. and the sides the ventilator pit is only ¼ in. on each side. At each end of the ventilator pit, and at the bottom on each side of the inlet from the upcast shaft, adjustable packing blocks of timber are fixed upon hinged iron frames, and can be adjusted with screws and nut; these blocks are set up quite close to the periphery of the rotary pistons within ¼ in. The clearance between the periphery of one of the rotary pistons and the center circle of the other is also the same, and thus in any part of the ventilator the clearance for loss by returning of the air is not more than ½ in.; this will account for the measured quantities of air in Table II., corresponding so closely with the calculated capacity or displacement, which is 5,800 cubic feet per revolution. Between the packing blocks I I the ventilator pit is dug out and lined with cement; but there is considerable space between the layer of cement and the outside circle of the rotary pistons, and dependence is placed only upon the packing blocks to maintain the tightness of the pistons with the ends of the ventilator pit.

The rotary pistons are equally balanced, and also the parts of the engine; and the friction diagram, taken during experiment No. 1, Table III., shows that 3·10 indicated horse power maintained the ventilator and engine running at a constant speed of three revolutions per minute; this shows that the balancing has had attention, and that not much power is lost in the friction of the moving parts. Clinton Colliery is a new pit raising 800 tons of coal per day, and the present requirements in the way of ventilation are amply met by running the ventilator at 15 revolutions per minute, giving a calculated displacement of 87,000 cubic feet of air per minute. At this speed better results would be obtained by using only one cylinder, and letting the other engine stand, as will be done in the case of repairs; the two engines are only intended to be used when the ventilator is working up to its full maximum quantity of 200,000 cubic feet of air per minute. The arrangement of the engine house and ventilator building is shown in the engraving; the discharged air escapes through perforated openings in the roof, and, owing to the very large area of outlet from the ventilator—the top of the ventilator casing being left entirely open—the air that is being exhausted from the pit must necessarily be delivered into the atmosphere at a lower velocity than is usual with other ventilating machines.

The tabulated statements appended, Tables I., II., and III., contain the results of experiments made at two trials of this ventilator. In the anemometer measurements, Biram's anemometer was employed, and the readings in Table I. are corrected by means of a table supplied with the instruments, which was tested for the purpose of these trials. In some of the experiments the anemometer and water gauge measurements were taken simultaneously with indicator diagrams, from both engine cylinders; some of the indicator diagrams are shown in Figs. 1, 2, and 3. The areas and position of upcast shaft and tunnel are shown in engraving; the sectional area of the tunnel is only 112 square feet at the point where the anemometer measurements were taken, which is much too small.

The useful effect obtained with this ventilator is shown in Table III.; and for the purpose of comparison, the following particulars are reproduced from the paper on mechanical ventilators for mines by Mr. Daniel at the meeting of the Institution, Nov., 1875, the lowest as well as the highest results being given in the case of the Roots' and the Cooke's ventilators, and the highest alone in the case of the others.

This comparison shows that the range of Roots' blower, when employed as an exhauster, is in advance of any of the previous mechanical ventilators; and in the writer's opinion this would be a decided advantage in the case of an explosion. When the air doors become disarranged, the ventilation of the mine is interfered with at the moment when it would be of the greatest service, and this owing to the limited power of fan ventilators, which can only be depended upon up to about 3 in. water gauge; but in a case of emergency, with a Roots' ventilator similar to the one described, the machine could be instantly driven at its maximum power, and would speedily clear the workings of the choke-damp, fire-damp, or after-damp. Since explosions cannot always be prevented, it is of importance that the deadly gases should be drawn out in the shortest possible space of time, and replaced with pure air; and from present experience this ventilator appears to be well fitted to suit these requirements.

		Ventilator. Diam. ft.	Ventilator. Width. ft.	Air per minute. cub. feet.	Water gauge. in.	Revolutions per minute.	Useful effect. Pr cent.
Roots	Chilton	25	13	74 928	4·00	12	76·35
				101,606	5·00	14	64·19
				67,312	2·75	12	56·30
				118,272	4·12	21	51·40
Cooke	Lofthouse	22	11½	101,308	1·12	26	64·00
				26,757	1·00	26	59·16
	Uplestham	22	11½	98,900	3·25	27	61·19
				120,816	1·56	29	58·56
Waddle	Aberaman	26	14	126,164	1·60	44	47·16
Hammell	Cannock Chase	32	?	45,280	2·10	55	41·02
Leeds Fan	Morley Main	40	10	141,534	1·80	44	37·92
Guibal	Farnley Wood	21	7	38,900	0·90	53	50·42
	Liverton	36	12	121,688	2·55	51	48·83
	Hilda	50	12	116,792	2·63	36	45·85
	Skelton	30	10	82,544	0·50	38	45·46
	Craggs Hall	30	10	56,072	1·40	43	40·69

THE ROOTS BLOWER.

The admirable paper herewith given upon the performance of the great Roots Blower, read by Mr. Carbutt before the Institution of Mining Engineers, London, and the accompanying series of engravings from our British cotemporary, *The Engineer*, are examples of the favor and rapid progress that American inventions are now making throughout Europe. This important invention is the discovery of Messrs. P. H. and F. M. Roots, of Connersville, Ind. Selling agents in New York, Cook and Beggs, 6 Courtlandt street. Some 2,000 of these machines are in use in England and nearly 2,500 of them on the continent. They are employed in the principal foundries, machine shops, gas works, etc.; while for mine ventilation they are unequaled. In this country the Roots Blower enjoys a very high reputation, and is most extensively employed. The admirable exhibit made by the patentees at the late Centennial Exhibition, Philadelphia, Pa., attracted the attention of engineers from all parts of the world, and more than confirmed, by actual performance, all that had been claimed by the makers.

Recently, says the *Milledgeville* (Ga.) *Reporter*, a little colored girl, nine years of age, daughter of Samuel Phelps, was passing over the railroad bridge which spans Fishing creek near the depot, with a large parasol stretched over her head, when the blast struck her, and in a moment she was swept off the bridge and was falling to the earth sixty feet below. A lady who saw the affair from a short distance off, says that she went down hanging to the umbrella, which was stretched over her head like a parachute. The handle broke just before she reached the ground. She was but comparatively little injured; the parasol acted as a parachute.

Table I.—*Roots' Mine Ventilator at Chilton Colliery, Ferryhill. Velocities of Air in Different Portions of Area of Tunnel.*

No. of experiment	3	4	5	7	8	10	12	16
Revolutions per minute of ventilator	10·5	12	13	17	18	21	23	27
Mean velocity of air	Feet p. min. 551	Feet p. min. 601	Feet p. min. 669	Feet p. min. 852	Feet p. min. 903	Feet p. min. 1050	Feet p. min. 1155	Feet p. min. 2185

Table II.—*Roots' Mine Ventilator at Chilton Colliery, Ferryhill. Measured and Theoretical Deliveries of Air at Different Velocities.*

No. of experiment		3	4	5	7	8	10	12	16
Date of experiment	1877.	Mar. 17.	Mar. 17.	Mar. 17.	Mar. 17.	Feb. 3.	Feb. 3.	Mar. 17.	Feb. 3
Revolutions of ventilator	R	per min. 10·5	12	13	17	18	21	23	27
Velocity of air in tunnel (Table I.	V	feet per min. 551	601	669	852	903	1050	1155	2185
Delivery of air: Theoretical* R × 5800 = T		cub. ft. p. min. 60,900	69,600	75,400	98,600	104,400	121,800	133,400	214,000
Delivery of air: Measured† V × 112 = M		Do. 59,472	67,312	74,928	95,784	101,696	118,272	129,360	244,720
Ratio	$\frac{M}{T} \times 100$	per cent. 97·65	96·71	99·37	100·18	97·41	97·10	96·97	114·04
Leakage		per cent. 2·35	3·29	0·63	—	2·59	2·90	3·03	—

* The theoretical delivery is the capacity of the ventilator (5800 cubic feet) × revolutions per minute.
† The measured delivery is the velocity in the tunnel × 112 square feet sectional area of tunnel.
In Nos. 4, 5, 8, 10 the air measurements in Table I. were taken simultaneously with those of indicated horse-power given in Table III.
The experiments Nos. 3, 7, 12, 16 are not carried out in Table III., the whole of the data not being obtained in those cases.

Table III.—*Roots' Mine Ventilator at Chilton Colliery, Ferryhill. Useful Effect of Ventilator and Engine.*
Engine with two cylinders, 28in. diameter and 4ft. stroke.

No of experiment		1	2	4	5	6	8	9	10	11	13	14	15
Date of experiment	1877.	Mar. 16	Mar. 16	Mar. 17.	Mar. 17.	Feb. 3.	Feb. 3.	Feb. 3.	Feb. 3.	Feb. 3.	Mar. 17.	Mar. 17.	Mar. 17.
Revolutions of ventilator and engine	R	per min. 3	8	12	13	14	18	20	21	22	28	30	32
Steam pressure in pipes		lb. per in. 33	35	37	40	45	45	46	49	48	45	52	63
Point of cut-off in engine		per cent. 30	30	30	30	30	30	40	30	40	30	30	30
Delivery of air: Theoretical..R × 5800 = T		cub. ft. p. min. —	46,400	69,600	75,400	81,200	104,400	116,000	121,800	127,600	162,400	174,000	185,600
Measured (Table II.)	M	Do. —	—	67,312	74,928	—	101,696	—	118,272	—	—	—	—
Water gauge	W	inches. 0·00	1·25	2·75	4·00	4·00	5·00	6·50	4·12	5·87	8·00	7·00	7·75
Mean effective steam pressure: Right cylinder		lb. per in. 3·47	6·65	14·47	—	17·65	22·89	29·80	23·85	30·95	—	46·40	51·15
Left cylinder		Do. —	—	—	13·55	17·25	23·75	29·30	23·70	31·25	39·85	—	—
I.H.P. from diagrams: Right cylinder		H.P. —	—	—	—	73·68	122·30	177·70	149·90	208·00	—	—	—
Left cylinder		Do. —	—	—	—	73·01	127·40	174·70	145·40	205·00	—	—	—
Mean	I.H.P.	3·10	15·50	51·79	61·44	73·84	134·85	176·20	149·15	204·09	332·70	415·00	488·00
Effective H.-P.: Theoretical $\frac{T \times W \times 5{\cdot}2}{33{,}000} = Et$	H.-P.	Frictional diagrams.	9·14	30·16	47·32	51·18	82·25	113·31	79·17	113·12	153·84	191·99	226·65
Measured $\frac{M \times W \times 5{\cdot}2}{33{,}000} = Em$	H.-P.		—	29·16	47·22	—	80·12	—	76·88	—	—	—	—
Useful effect. Ventilator and engine: Theoretical $\frac{Et}{I} \times 100$	per cent.		58·96	58·33	77·34	70·26	65·70	67·43	53·09	57·20	46·24	46·26	46·24
Measured $\frac{Em}{I} \times 100$	per cent.		—	56·29	76·85	—	64·79	—	51·49	—	—	—	—

* Abstract of paper read before the Institution of Mechanical Engineers, London.

LESSONS IN MECHANICAL DRAWING.

By Professor C. W. MACCORD.

Second Series—No. XIV.

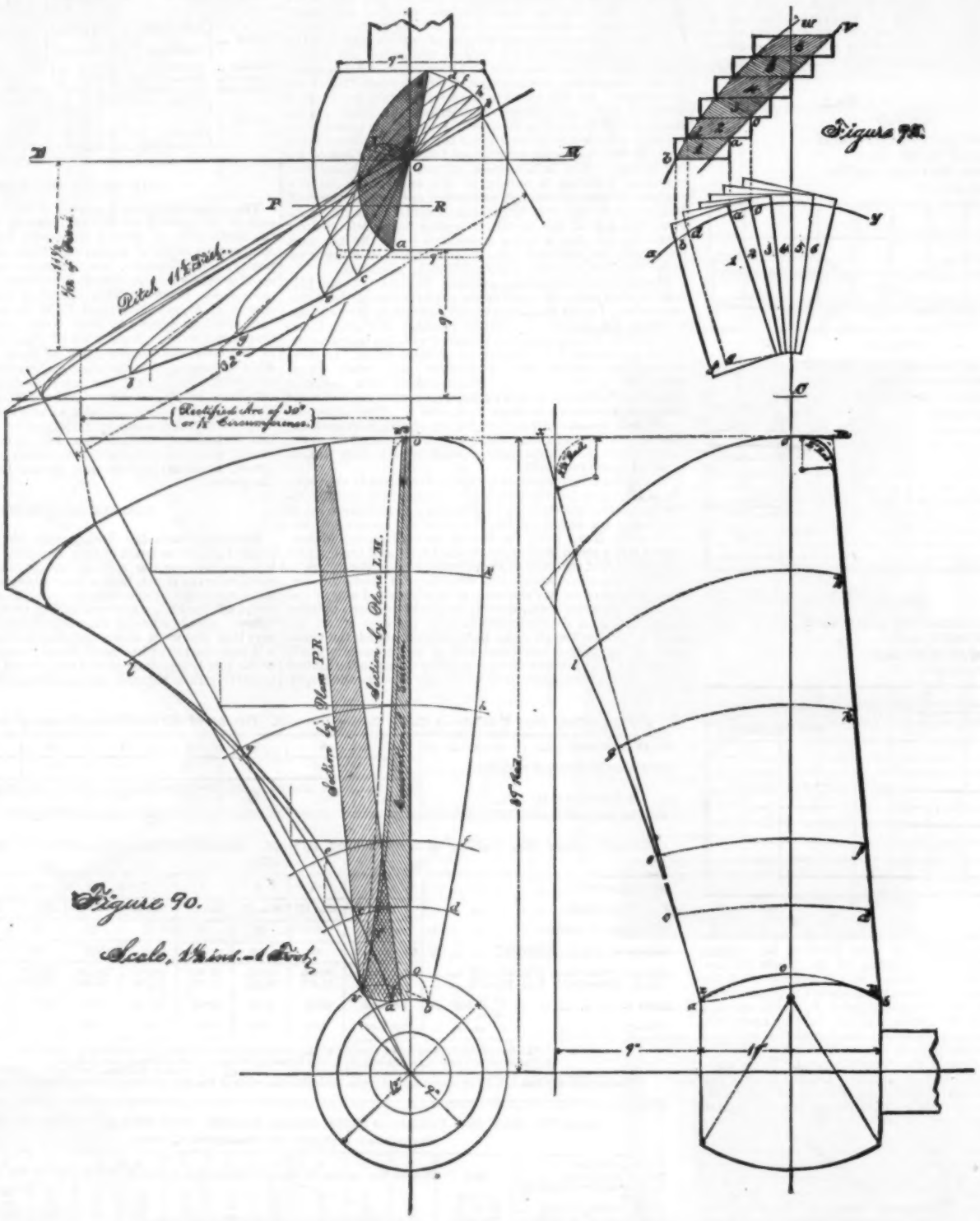
On the Screw Propeller. (*Continued.*)

THE wrought iron propeller was selected for discussion first, because it afforded the best illustration of a screw-thread of uniform thickness, as well as excellent practice in the methods of representing the peculiarities of surfaces of kindred nature. We shall now suppose a propeller to be required, as before, of 6½ ft. diameter, 11½ ft. pitch, with the same conditions as to overhang and breadth of blade as in Fig. 81, but to be cast in one solid piece, and with a hub not cylindrical, but larger in the middle than at the ends, as shown in Fig. 90. The acting face, or elementary blade is, therefore, precisely the same as in Fig. 81, except in relation to the intersection with the hub, and the mode of constructing this was explained in connection with Fig. 72, Lesson IX of the present series.

If the forms of these sections be known, then, there is no difficulty in making the drawing. But there arises a question at once as to what these forms shall be. We may assume that of the lowest one, at the junction of the blade and the hub; that is, we may assume the form of the back line, the front one being, not a true helix, but at any rate something like one, and known, since it is the intersection of the face and hub. And at the rim, the form is also given, being a helix at a constant distance from the front one, if for the moment we suppose that the edge of the rim is not to be rounded off. Now, what is to be the outline of any intermediate section? In the first place, we draw in the end view what we shall continue to call the *conventional section*, *w v*, as in Fig. 82, representing the desired *normal* thickness of the blade at all points along the central element *o o*. Then drawing perpendiculars to *o o*, we lay off in the top view the normals of the corresponding lengths in their true positions, as in Fig. 85; the extremities of these normals are then projected back to the perpendiculars in the end view, and a curve is drawn through the points thus determined.

This curve, *s r*, is one projection of a line, of which the other will be the curve *s' r'*, drawn in the top view through the ends of the normals, all as in Fig. 85. But this double curved line is not the generatrix of the back surface, in the same sense as in the previous case; although we may imagine that surface to be generated by the motion of this line in connection with the element *o o*, if we also suppose the line to change its form as it moves. In the present instance we use this curve merely to fix one point in each of the required cylindrical sections, thus: In the end view each circle cuts *s r* in a point, which is projected to *s' r'* in the top view; this locates the point at which the normal pierces the surface of the cylinder of which the circle is the base; and as the length of the normal from the mode of its determination satisfies the required condition, the section by this cylinder must pass through its extremity. Now the sections must be bounded in front by the helices cut from the acting face by the cylinders, and the backs must gradually change, the sections being shorter and broader as we approach the hub, longer and narrower as we approach the rim. But if we assume their forms outright, we shall not be sure that the surface thus defined will be a regular, or, as it is technically called, a "fair" one. Possibly an abstruse mathematical investigation might enable us to deduce a law for its generation by a line which changes its form while moving, as above suggested; but aside from the intrinsic difficulties of such an operation, its practical utility is questionable. All the requirements of practice are more readily met as follows: We, in point of fact, do assume the sections, taking them so close together that we can judge, not with perfect precision of course, but with a reasonable degree of accuracy, of the change of form in passing from one to the other; but we do not rely upon our judgment alone for the correctness of these sections.

The assumed outlines are first lightly but clearly pencilled in, or at least a part of each for a short distance each side of


Pitch 11½ feet.
(Rectified Arc of 30° or ⅛ Circumference.)
Section by Plane P R.
Section by Plane L M.
Projection of Section.
Figure 90.
Scale, 1½ ins. = 1 Foot.
Figure 91.

LESSONS IN MECHANICAL DRAWING. SECOND SERIES, No. 14.

This is the usual way of making the propeller; and the difference between this and the preceding example consists chiefly in the conformation of the back. The manner in which the peculiarities of this surface are shown, is precisely the same as that adopted in showing the hub of the wrought iron screw, and illustrated in Fig. 87; that is to say, a series of concentric cylindrical sections are made, as though the propeller were to be put in the lathe and successive reductions made in its diameter.

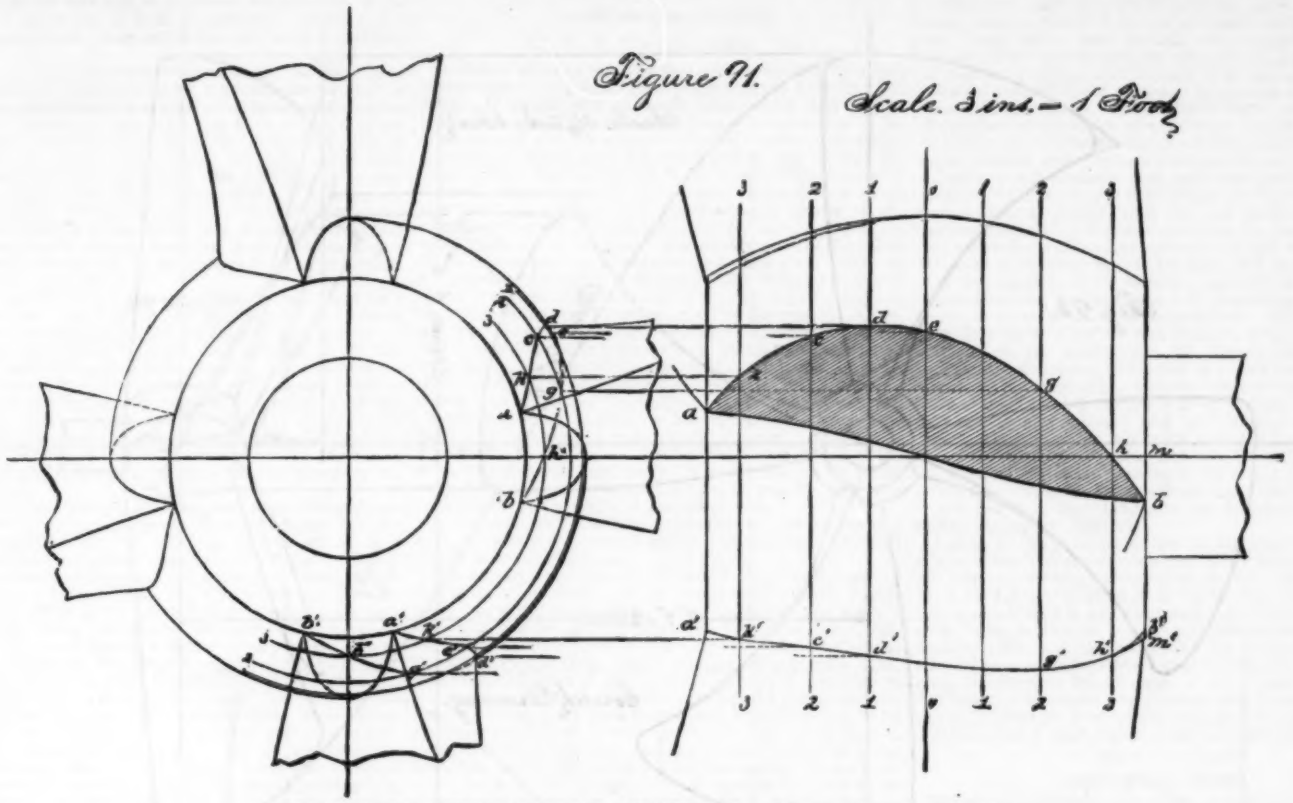
The lowest one, whose first line is *a b*, however, is not a true cylindrical section, but it shows the junction of the blade with the hub, just as if the former were turned off so as to leave a thin film only.

Lines drawn tangent to the projections of these sections, as seen in the top view, and parallel to the axis, may then be considered as lying on the surfaces of the cylinders by which the sections are made, appearing therefore as points of the invisible contour of the back, when projected to the corresponding circles in the end view, as in Fig. 87.

regular character. Prolonging the outlines as thus corrected, we again test them by making another transverse section at a short distance from the first, and so on, until we have made the cylindrical and the transverse sections tally with each other, and also made both sets of lines fair and regular curves. When this has been accomplished, the sections being taken, as above intended, tolerably close together, it will be apparent that we shall be reasonably certain that the surface itself as determined by these lines will be a fair one, and that intermediate sections will be, as they should be, also bounded by smooth and regular outlines.

extending from end to end, must cross all these circles. The central plane, *L M*, cuts the curve at *e*, which is projected to the outer circle in the end view; the plane 1–1 cuts a circle from the hub, which in its turn cuts the back outline at *d*, which is projected to the corresponding circle in the end view, and so on.

Inasmuch as the assumed outline at the back is not symmetrical, as the front is, but has different curvatures toward the aft and forward ends of the hub, it is necessary to make sections at different points all along the line; but by making them at equal distances on each side of the center of the hub, known, the model could be reproduced by reversing the order of proceeding. The strips would be placed up to the proper thickness, dowelled, then taken apart, and the proper line marked on each one. The strip being then worked down to those lines, without however sloping the sides, we should have, on putting them together, an approximation to the form, but with projecting steps, which being finally removed, by means of gouges, chisels, files, and sand-paper, we should have the required lines joined by a continuous surface identical with that of the original. In like manner, the pattern of the screw-blade may be built up; again using

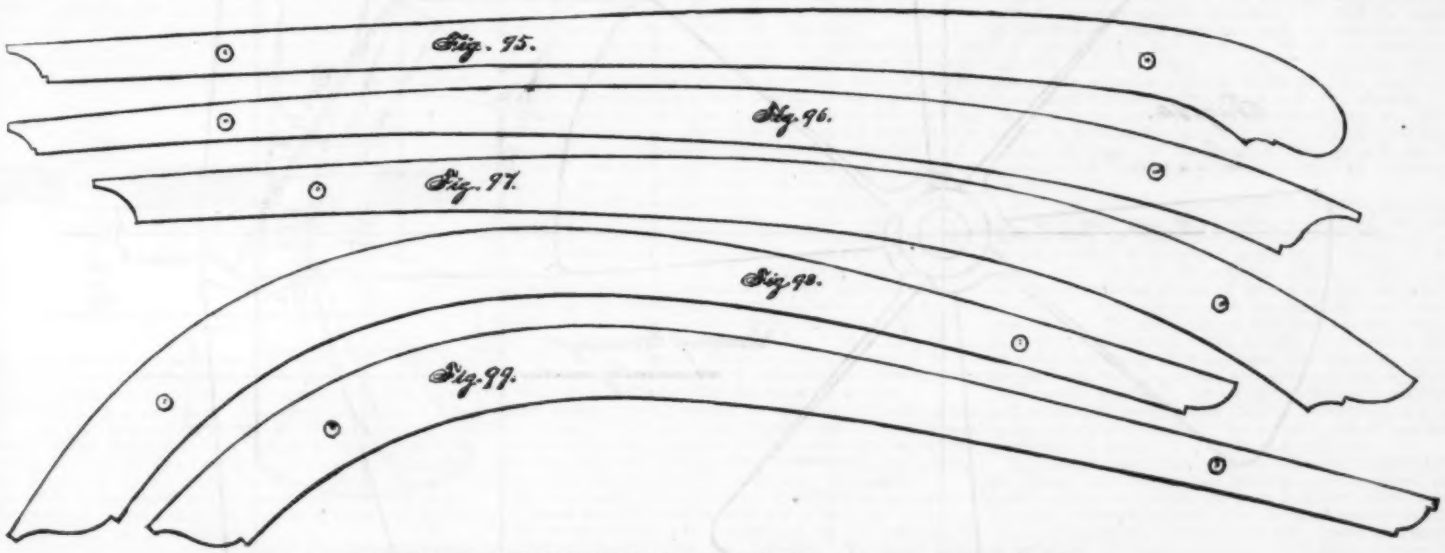


LESSONS IN MECHANICAL DRAWING. SECOND SERIES, No. 14.

In regard to the actual distances between the sections, we must be guided by the considerations that the closer they are to each other the more accurate will be the results, and that, the more rapid the curvature and the variations of curvature in the surface, the closer must the sections be in order to develop the form of the outline with precision. The latter principle will be recognized as an extension, or rather an application to a surface, of the similar practical consideration that in drawing a curve by locating points according to any law, these points must be nearer together the sharper the curve. And in regard to the form of the true

we have but one set of circles in the end view, because the outline of the hub itself is symmetrical about the center. We have shown a portion of four blades in the end view, of which three will be visible in the side view—really the fourth would show a little at the aft side, but as on the forward side it would be concealed by the shaft, it is omitted altogether. The side view of the curves in question, if we regard the two vertical blades, will be identical with a top view of the horizontal one after being revolved through an angle of ninety degrees; the points are accordingly indicated by the same letters with the addition of an accent, which

an old illustration, we may imagine a winding stair to be made with very low steps, by placing a number of boards one over the other, so that their edges shall overlap each other uniformly, while radiating from a common axis; the lower edge of each board would be an element of the acting face, and if the little steps thus formed are smoothed away, the true helicoid will result. Each of these boards, then, may be regarded as the part of blade included between two transverse sections; and if the proper line be laid out on the back, and the above process repeated, we shall have both surfaces of the blade. The mode of operation may perhaps



LESSONS IN MECHANICAL DRAWING. SECOND SERIES, No. 14.

section by the plane *L M*, shown in the end view in a dotted line, the reader will no doubt perceive that the discussion of the case in which the blade is of uniform normal thickness will aid him in judging of the nature of that outline, which will differ from the conventional section, in being proportionately much broader at the rim than near the hub: which indeed may be seen from another point of view, by reflecting that this plane cuts the outer part of the blade much more obliquely than it does the central regions.

The drawing of the curve of intersection of the hub by the back of the blade demands a little separate consideration, and in order to avoid confusion, we give an enlarged view of this part of the propeller in the diagram, Fig. 91; the intersection with the acting face is also shown, but, its construction having been previously described, we confine our remarks wholly to the former. The principle is simple enough, but the peculiarities of this curve cannot be well shown on the smaller scale.

The hub being a surface of revolution, every transverse section will be a circle; and the curve (*a e b* in the top view),

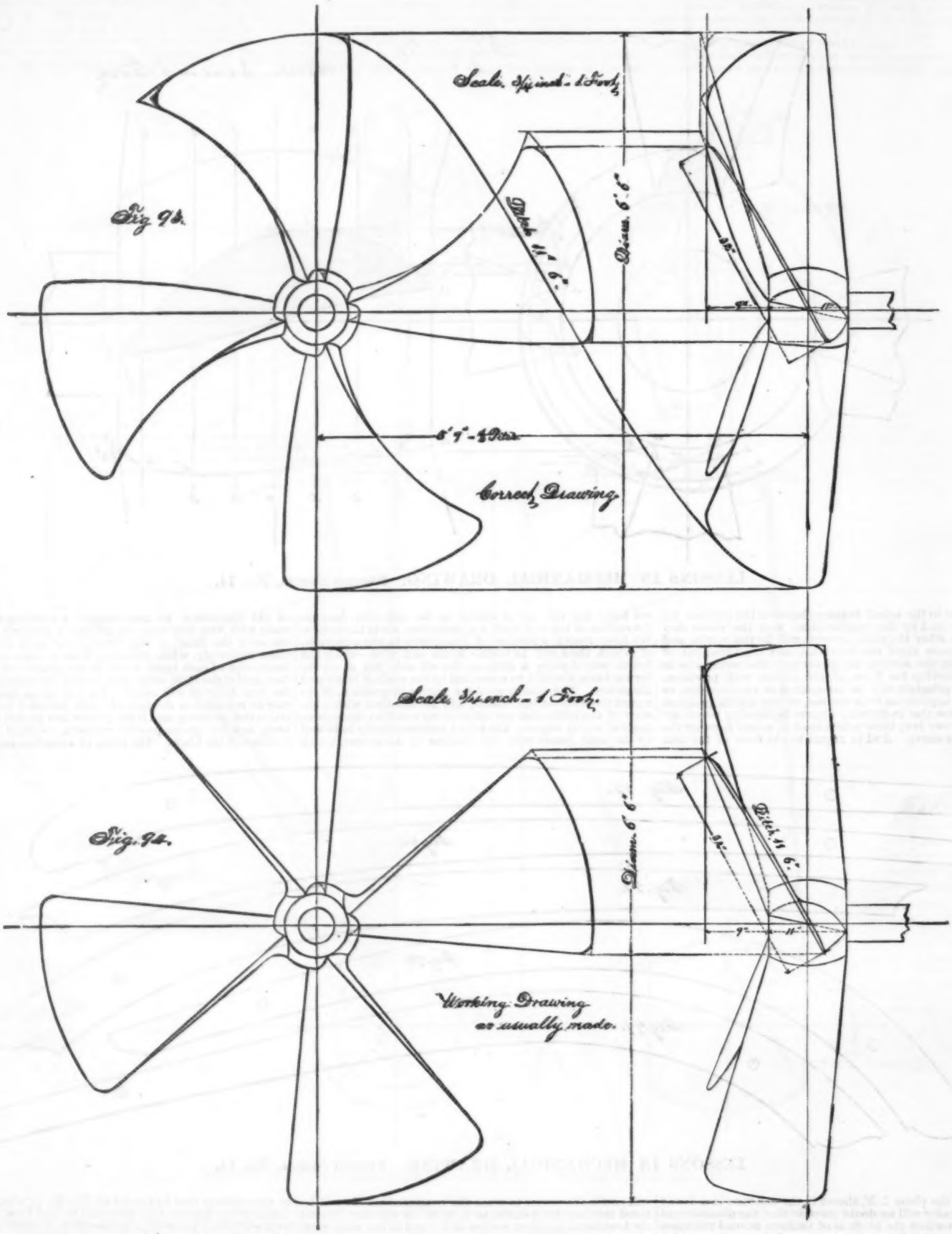
will enable the reader to trace the construction. It will be noted that the back curve, as seen in the top view, crosses the horizontal meridian section at *h*; and in the same view of the upper and lower blades the intersection will for that reason appear *tangent* to the meridian curve at *h'*, so that, in the case of the lower blade, of which we see the back instead of the front, the small arc *h' w'* is all of the meridian outline which is visible.

Now, it may be asked, how does the drawing enable the pattern-maker to shape the pattern, should one be required? To this it may be replied that the process of making the pattern is analogous to that of making a model of a vessel. We presume that our readers are aware that such a model is usually made, not of a solid piece, but of a block built up of a number of thin strips, dowelled together. After the model is satisfactorily shaped, these strips may be separated, and by tracing the outline of each on paper, we have a series of sections of the body of the vessel by horizontal planes, technically called the "water lines." Now supposing those lines to be given, the distances between the planes being also

be more clearly seen by the aid of Fig. 93, in which *C* is the center of the propeller as seen in the end view, *b f* is the back outline of the section by the plane forming the nearer side of the piece marked 1, *d e* that of the next, the plane coinciding with the nearer face of 2; the top view represents a cylindrical section corresponding to the circle *x y* in the end view; and it will be seen that if the boards are cut to these outlines, and the same course be pursued with those beyond, the removal of the steps in front will give the helix *a v*, and if those at the back are cut away the curve *b w* will be formed. It has already been stated that in making the propellers whose acting forces are true right helicoids, wooden patterns are not required; the mode of striking up the helicoidal face has been explained; as for the blocks, the mould is made either by excavating in the sand, whose surface is first struck up to the proper form, so as to fit the mould for the face, a hollow such as would be made by a pattern if used, or by making first what is in fact a pattern of sand, which the moulder fashions with his trowels; a mould is made from this as though it were a wooden pattern.

and when the mould is lifted off, the sand pattern is destroyed.

But there are propellers which cannot be readily struck up, and manipulated in these ways—and patterns are required, for which accurate drawings are absolutely essential. The making of these, which are more complicated than any yet discussed, it is easy to see would hardly be accomplished with satisfaction by one to whom the preceding constructions were not clear. Beside all which, as we have previously remarked, the fact that incorrect drawings will answer because no drawings at all are needed is not in any sense a reason why



LESSONS IN MECHANICAL DRAWING. SECOND SERIES No. 14.

that which pretends to be a drawing should be a caricature; and, aside from the satisfaction which ought to be felt at making it correctly, it must not be forgotten that the drawing is, very naturally, referred to for purposes of calculation and comparison, which is a cogent reason for having it so made as to afford reliable data.

By this, however, it must be understood, we do not pretend to insist on expending the labor involved in a minutely accurate determination of the surface of the back of the blade in every instance. If the screw is to be struck up, without patterns, this would be a useless waste of time; in a propeller of the general form of the one under consideration, all requirements of practice would be met by giving two or three sections between the hub and the rim, with such a degree of accuracy as can be attained by one correction made by the use of two transverse sections. But the acting face ought to be accurately drawn, since it is in reference to the extent and distribution of this surface that measurements for the purposes of calculation and comparison with other propellers are likely to be made. And as an illustration of the nature and degree of the difference between a correct representation and what might be supposed to be one because the screw was made from the data given by it, the two are contrasted in Figs. 93 and 94.

The propeller is the same as that shown in Fig. 90; Fig. 93 is an accurate drawing of the complete screw with its four blades, and Fig. 94 is a "working drawing," made as a great many such drawings are and have been made, for the purpose of construction. And when the screw has been struck up and cast, it will look precisely as it appears in Fig. 93. This, be it understood, is said not simply because it ought to be so, but it has been proved to be so by actual observation; a screw which was made from a drawing substantially similar to the working plan here given, was carefully measured, and as carefully drawn from the measurements thus obtained. Another drawing was also made from the original data, but correctly, as explained in connection with Fig. 90; and these two drawings tallied with each other almost precisely.

It needs but a glance at these two figures to see that the idea of the appearance of the screw, and of the distribution of its acting surface, conveyed by the latter, is most inaccurate; and a pattern-maker, if required to make a pattern or a model of this screw from this drawing, would clearly have an impossible task, on account of the discrepancy between the two views themselves, and between either of them and the correct representation of what is required.

Now, in making a drawing of this kind, when there are four blades exactly like each other, it is not of course necessary or advisable to go through the drudgery of constructing each one. We have before explained a mode of saving time in such cases, which will bear repetition. Having completed the outline of one blade, then, trace it carefully on a piece of tracing *paper*, in ink or pencil, and draw also the vertical and horizontal center lines; turn the tracing over, and with a moderately soft pencil go over the lines, on the back of the paper. Then turn it over again, and place it in position for drawing the next blade, which can be accurately done by the aid of the center lines, and again go through the motions of tracing, using the sweeps with care, and employing a rather hard pencil, not too

sharply pointed, lest the thin paper be cut through, and handling it with a firm and decided pressure. This will leave a clear and correct impression of the outline on the paper beneath, and by repeating the operation the three blades may be thus pencilled and inked in less time than it would take to construct one of them anew.

We have before remarked that the constructions herein described, when made as exercises for practice, will be found much more satisfactory, as well as easier, if made on a large scale. And this is equally true in regard to the working drawings, if a model or a pattern is to be made from them; for this purpose, the details of such a blade as that given in Fig. 90 ought to be drawn full size; but if the screw is to be struck up without patterns, a drawing on a scale of an inch and a half to the foot will answer perfectly well.

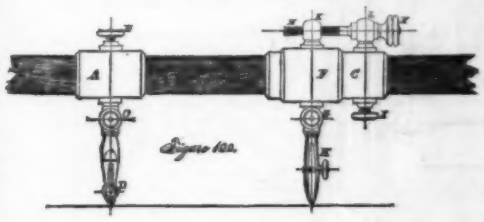
Such large drawings, involving as these do many non-circular lines of slight curvature, evidently are beyond the range of the instruments and appliances heretofore enumerated. As a guide to those who may have occasion to use such articles, we give in Figs. 95–99, the outlines of some of the sweeps, or curved rulers, which we have found most useful in work of this description, the drawings being one-fourth the actual size of the instruments. It will be observed that these sweeps are bounded by long continuous curves, each being a mathematical line of definite character with a reputation to sustain, and what is more, sustaining it unblemished, and making no pretensions to be a "universal" curve, which some sweeps do.

But the circular arcs required in these constructions on a large scale, are also beyond the capacity of the jointed compasses. Instrument dealers are fond of pointing out to purchasers the peculiar beauties and advantages of that miserable makeshift called a lengthening bar, to which we have before alluded, and explained the only purpose to which it is really well adapted, which is, to be thrown out of the window, the vacancy in the case to be filled by a good drawing-pen. When circles of over a foot radius—indeed we had almost said over a foot in diameter, are to be drawn, the the best instrument for the purpose is what is known as the beam compass.

Of this there are various modifications, some of which are well adapted for special purposes, others ill adapted for any purpose whatever. We will illustrate in Fig. 100 the best arrangement for the ordinary operations of mechanical drawing. It consists essentially of two sockets, *A* and *C*, which slide freely on a wooden beam, *B*. The socket *A* has on the top a binding screw *E*, by which it may be clamped at any position on the beam; the point of this screw does not press directly on the wood, but on a spring or slip of metal fixed inside the socket, for the purpose of distributing the pressure and preserving the beam from injury. This socket also has at the bottom a cylindrical projection *O*, drilled for the reception of the shank of either a needle-point *D*, as shown in the figure, or a solid point The other socket *C*, is provided with a similar binding screw *I*, but on the lower instead of the upper side. It also carries a fixed stud *L*, which forms a bearing for a journal, which is a prolongation of the screw *M*, turned by the milled head *N*. The nut for this screw is the stud *K*, fixed to another socket *F*, which is accurately fitted to slide on *C*, and is provided below with a projection *G* arranged like *O* for carrying a movable point, pen, or pencil. Thus when *C* is fixed to the beam by tightening the binding screw *I*, which is done after the points are adjusted as nearly as may be by hand, we may complete the adjustment by turning the milled head *N*.

Having said that this is the best arrangement, it is proper to say why it is; because in regard to this as to other things, dealers are apt to wish to sell what they have, and are very likely to have in stock one or two very bad designs, against which we wish to warn the inexperienced.

One of the worst and most common of these has the socket *A* not closed, but open at the top, with the binding screw on the side; "Now you see, my dear sir, how much more convenient this open box is; you do not have to fit a beam to it, but you can use any flat ruler you happen to have." So you can—and very awkwardly at that; you have to move the hand from its natural position in holding the instrument around to the front in order to loosen the clamp,



and when you have done it the socket drops off. The other socket *C*, is open for the same reason and to the same objection; beside which the slow-motion adjustment is necessarily below, thus needlessly elongating the points. Very often too that adjustment is effected by having the pen or pencil carrier movable on a horizontal pivot, making it in fact the vertical arm of a bent lever, of which the horizontal arm is moved by a vertical screw; probably the worst adaptation of bad means to a good end ever contrived by any human being, unless indeed the device of the open socket may share that bad preëminence.

Another, but by no means so bad an arrangement, is that in which the socket corresponding to *C* is closed at the end, the beam being fitted into it and fixed there; in this case *C* carries the pen or pencil, and another socket also closed at the end is fitted to slide over it, the two being connected by a screw having its journal in the end of the outer one. The fine adjustment in this arrangement is conveniently made; but the disadvantage consists in having the socket fixed at the end of the beam; for if it be required to use a short radius, the long projecting part of the beam throws the instrument out of balance. And this is very often required; in drawing our propeller, for instance, we have a number of circles to strike from the same center, and having set off the radii by the scale, we can very conveniently draw all the arcs with a beam compass like that shown in the figure. A two-foot beam enables us to draw a circle nearly four feet in diameter, while by shifting *both* sockets toward the middle, thus preserving the balance of the instrument, we can very readily draw a circle of four inches in diameter. And in this arrangement the whole adjustment is most conveniently effected; the beam is naturally supported by the second and third figures of each hand, and without removing this support, the screws *E*, *I*, and *N*, are manipulated with perfect ease by the thumb and first finger.

The length of the beam of course may be whatever is required by the nature of the work; it is most convenient to have two or three of different lengths in an office, say two, three, and four feet in length respectively. They should be of thoroughly seasoned, hard, fine grained wood, such as rose-wood, satin-wood, or mahogany, and nicely fitted so as to slide freely, but with as little shake as possible, through the sockets when the screws are slackened. The figure, it may be remarked, is carefully drawn of the half size of an instrument of very convenient size and weight for all the ordinary operations of the draughtsman.

CARRIAGE PAINTING.

By W. H. STEWART, Orion, Wis.

A NICELY finished wood surface may be spoiled by a little carelessness on the part of the painter, as the following will show. If rough stuff be used rather thick, and laid on with a coarse stiff brush, then the heavy brush-marks in the first coat will give the surface a kind of corduroy or ribbed appearance, and as each successive coat is laid on with the coarse brush, the bristles will divide on the ridges formed in the first coat, and travel in the grooves, scraping most of the new paint out of the grooves, and leaving a surplus on the ridges, each successive coat consequently increasing the unequal thickness of the paint. The thicker parts of the paints do not dry as hard as the thinner, and thus when cut to an even surface, the softer parts, where the ridges were, will shrink while the color and rubber varnish is going on, and the color surface will be pulled down by the unequal shrinkage, and when the finishing coat goes on, it will show the exact condition of the color surface. Repeat the experiment with the same coarse brush, and, if you think you can overcome the difficulty and outwit natural law, brush each alternate coat crosswise, thus filling up the grooves of each preceding coat, but finish up as before, and in a few days the surface will appear like basket work or canvas. I have seen this effect when laying on the finishing coat, when, if the work were not examined closely, it would be taken for pitted varnish, but the only fault in the varnish was its making a public show of the faults of preceding coats.

If the roughstuff is left in a daub or an uneven manner near the ends and corners of panels, the finishing coat will also be sure to tell the tale.

I would say, then, that if you would improve the quality and finish of the work, have the rough stuff of such consistence that it can be laid with a nice, fine brush, and apply it as carefully as the last coat of color. Lay on as little roughstuff as will insure a good surface, and let it stand as long as cirumstances will allow before putting on the guide coat. I don't like the idea of giving the under coats less time to harden than the guide coat. It is true that the guide coat cuts better by being dried more thoroughly, but if either is to be shortened in time, let it be the guide, for the under coat is going to harden sometime; and in that hardening, it is going to shrink, and better shrink before the surface is cut than after; for it is folly to talk of good quality or good finish over a green foundation. It is of no use to try to improve the irregular surface by laying on and cutting down a heavy body of rubber varnish, for when the finishing coat is laid on, then all the varnish coats become transparent alike, and they tell exactly the condition of the surface of the first opaque coat under it. Be sure you are right at the start, but do not then smash ahead, but go carefully; and be sure you are right *all along*, and the quality and finish will be all right too. Let me add that ground pumice mixed with the other materials used for last coat of roughstuff and guide coat will greatly assist its cutting quality, and thus lessen the labor and shorten the time required in cutting down.

When the roughstuff surface is made, give it a thin coat of P. W. F., thoroughly rubbed in, then wipe off immediately, before allowing it to dry, all that can be got off with a clean cloth, and give time to dry before laying on the color. This prevents the porous roughstuff from absorbing the oil, of the varnish, and from causing the latter to flat out.

If any one thinks that roughstuff will not absorb oil, let him coat a panel with raw oil on the naked wood, let it dry ten days, lay on one coat of lead, then four coats of roughstuff; let it dry four days; then cut down the surface, and let it stand ten days without coloring, and he will find the surface appearing very much like the coat of a dappled gray horse, for the oil or priming will have been absorbed by the roughstuff, and will show itself at first in spots, and if let stand long enough, it will finally show a dark oily surface all over. The oily substance will be as readily absorbed from the outer as from the inner surface. I once took the advice of an old painter, and painted a fine cutter as last named, and the work was ruined, for the varnish perished on it in a few days. On the contrary, P. W. F. between the roughstuff and varnish forms an *impassable barrier* between the oily varnish and dry porous roughstuff, and what is laid outside of the P. W. F. must remain outside, and what is laid under must remain under. Its language is: "Thus far and no farther shalt thou come." Thus the above coat of P. W. F. on the surface of the roughstuff increases the durability of the work by holding out the fullness of the varnish.

I am satisfied that finishing varnishes have many times been condemned for not flowing well, when the truth was that the surface had changed between the time of cutting down the roughstuff, and applying the finishing coat, and the change thus going on had given the wavy appearance.

Now, in regard to increasing the durability of the work, I have stated that the wood surface was changed to a certain extent by expanding and contracting, as the atmosphere changed alternately from wet and dry. To avoid this change in the surface, the only way is to render the wood as impervious to water as possible, and I know of no better way than to give the work a good coat of P. W. F., both outside and in. The P. W. F. seems to enter the open cells and other pores of the wood, and to form a more impassable barrier between the inner wood cells and the outer atmosphere than any other priming now in use. I have had good success in laying the roughstuff on the P. W. F. without lead coats between. Jobs now three years old are in first-class condition made in that way. I have never known paint of any kind to peel or chip off from the P. W. F., but have often seen paint leave a priming of oil and lead. I have also often known glue joints to become loose by exposure to damp after being primed with oil and lead, but never where they were primed with P. W F. Very much depends on the protection of glue in giving durability to both wood and paint; for if joints become loose then water enters, the panels swell, and away go all together.

It is understood that the color coat, in order to hold out the fullness of the varnish, must be hard; and being hard, it is non-elastic; and being non-elastic, an expansion of the surface on which it rests as a basis would be liable to break up the color coat, and the transparent varnish would show the broken color surface and then the finish would be ruined, not being durable.

To avoid this deviltry, the first coat of priming should be elastic and yet strong; the next coat should be somewhat harder, to enable it to partially overcome the expansion and contraction going on in the wood and priming, but not too hard, lest it break; and the next a little harder—thus increasing the hardness of each succeeding coat, while that on which the color is to rest should be nearly as hard as the first color coat. Thus we make a gradual decrease of elasticity from the wood to the glazing coat, and consequently a gradual resistance to the motion or expansion of the wood.

The outer coat of varnish, however, must be elastic for many reasons, which it is not necessary to enumerate here, one being that it may expand and contract by alternate changes from heat to cold, or *vice versa*, in the atmosphere. If then we would protect the color from the influence of that outward expansion and contraction, the first coat of varnish should be quite hard, the next more elastic, and so on with the surface of the under varnish, or all but the first coat may be cut away, and the finishing coat thus be laid immediately on the hardest under coat, making an abrupt transition from a hard to a soft or elastic coat, and thus destroying the durability of the work; for if the finish or elastic coat is laid immediately in contact with the first hard under coat of varnish, then, when the hot sun warms up the surface, the oily substance will become more limpid and will pass from the outer or finishing coat to the more dry under coat, and, thus the durability of the finishing coat will be taken away.

Another point in connection with improving the quality of the work deserves to be mentioned here. When the under varnish is cut to a surface with pumace, if it is polished with rotten-stone, the semi-porous and hungry condition of the surface will disappear, and it will not only be found much smoother, but more dense, and not being so much of an absorbent, the finishing varnish will lie entirely outside of all in its purity and fullness, and its brilliancy and clearness will thus be improved; moreover, it should be remembered, that the pumice is very sharp and cuts furrows in the varnish, turning up flakes that hold fast to the surface, and if left in this condition they penetrate the finishing coat, just in proportion as they penetrate the finishing coat, just so much is the latter deadened.

Lastly, let the finishing be laid in the least possible time and with the least possible amount of brushing. The whole job may be done ever so well up to the last coat of varnish, yet if the brush is allowed to touch the varnish after it has begun to set, then it will be ruined. A brilliant surface can never be made with the brush, but the varnish must itself produce a fine looking-glass surface by flowing, and it has scarcely time enough to flow nicely before sitting, even if it could be spread on by one dash of the brush. Remember that it begins to harden immediately after it has been spread and exposed to the atmosphere, and its *finest flow* is when it is in its *softest or most limpid condition.*—*The Hub.*

ARTIFICIAL GEMS.

WHAT we popularly call paste is technically known as strass; that is also the French word for the same substance (from M. Strass, its reputed inventor). Paste, then, is a material with which diamonds are imitated, and by mixing up with it metallic oxides of various kinds, colors in great variety are imparted to the paste, by which it serves as a representative of the various colored gems. Strass is prepared, according to the method of M. Donault, who has attained great proficiency in this art, from silica, potash, borax, oxide of lead, and sometimes arsenic. Rock crystal and flint consists almost entirely of silica; but as flint generally contains a little iron, the silica obtained from it is liable to have a tinge of color, which is detrimental to the fidelity of the imitation; rock crystal is therefore employed.

The crucible in which the materials are melted claims particular attention, since, if the substance of which it is formed contains metallic particles, color will be imparted to the strass. Hard porcelain and Hessian clay are the best materials for this purpose. When the crucibles are supplied with the proper quantity of ingredients, they are placed in a porcelain furnace, where they are exposed to a steady heat for twenty-four hours, and then allowed to cool very slowly, so that a kind of annealing goes on. By this means is produced a strass, or paste, which, after passing through the hands of the lapidary, who gives it the form necessary for "setting," presents us with an imitation of the diamond.

Having once produced strass which imitates diamond, all the other gems may be imitated, by mixing with strass various metallic oxides and other substances, according to the color which it is desired to produce. Herein is manifested great diversity of opinion, different experimenters advocating different modes of procedure and different ingredients. One experimenter recommends the following ingredients:—To imitate topaz, add glass of antimony, precipitate of Cassius, and oxide of iron, to the white strass; for ruby, add oxide of manganese; for emerald, oxides of copper, iron, and chromium, and acetate of copper; for sapphire, oxide of cobalt; for amethyst, oxides of manganese and cobalt, and precipitate of Cassius; for beryl, glass of antimony and oxide of cobalt; for garnet, glass of antimony, precipitate of Cassius, and oxide of manganese.

M. Donault has given directions somewhat different from the above; but we (*British Trade Journal*) need not particularise them, as it would carry us into too minute details. We may, however, mention that he produces the imitative rubies by a particular treatment of the composition employed for topaz. This composition is 1,000 parts of strass to 40 of a glass of antimony and 1 of purple of Cassius; at a certain stage of its preparation it affords an opaque mass, translucent at the edges, and affording thin laminæ of a red color. A part of this opaque topaz matter, added to 8 parts of strass melted in a Hessian crucible, and left 30 hours in a potter's furnace, affords a beautiful yellowish crystal. If this crystal be remelted by means of a blowpipe, it produces a strass nearly equal to the finest Oriental rubies. The art of producing imitative gems, ingenious as it is, is necessarily a confined one; for as soon as faithful copies of certain jewels are obtained, the object of the art is attained. The object is to deceive the eye; for, as M. Dumas remarks, "the most perfect description of strass, if it imitate no particular and identical gem, has no value, because it deceives nobody." There is less perfect but a curious mode of producing artificial gems, with what are called doublets, by a process of cementation. The artificial gem consists, in this case of two pieces of white transparent glass, or of crystals, which is cut into two pieces, conjointly so shaped that both together present the external form of the gem about to be imitated. A transparent cement is then formed of Venice turpentine and mastic melted up together in certain proportion, and to the mixture is added a portion of some coloring ma-

ter of the nature of the gem. Carmine, crimson lake, Prussian blue, verdigris, dragon's blood, Spanish annatto, etc., are employed, either separately or mixed one with another, until the required tint is imparted to the gummy mixture.

SONOMA TIMBER

IN Mr. Thompson's "History of Sonoma County, California"—he gives the following description of the redwood forests of that section:

Sonoma county possesses one marked advantage over most of the agricultural counties of this state. It has an immense source of wealth in its timber. The great redwood timber belt commences in Humboldt and reaches down the coast for 150 miles, terminating in Sonoma county. From the Valhalla—the north boundary line of Sonoma—to the mouth of Russian river, the country along the coast is timbered. The timber grows inland from the sea shore for about eight miles. Russian river turns around the town of Healdsburg and flows west; just after leaving the valley it enters the timber region, through which it flows to the sea. A branch of the San Francisco and North Pacific railroad leaves the main road at Fulton and runs into this timber, terminating at Guerneville, a lumber manufacturing center. The timber of the Russian river bottom is not surpassed on this coast. Fed by the rich, alluvial soil and watered by the annual overflow of the river, the trees grow to an enormous size. Some of them will measure 15 feet in diameter and over 350 feet high. They grow to the height of 150 feet without lateral branches, the bole of the tree preserving a remarkable uniformity of size. In some cases a single tree has been worked up into 65,000 feet of lumber, worth at least $1,000. The wood in the tree standing is valued at $3 per thousand feet. One hundred and fifty thousand feet to the acre, 4,000,000 feet on a 40 acre tract, is an average of good land. The very finest timber on the margin of the stream would produce at least 800 000 feet to the acre, and the yield runs downward from that figure to 25,000 feet to the acre.

The redwood belongs exclusively to the foggy coast regions; south of San Francisco the supply has been cut out, and as it grows nowhere else, either north or south, Sonoma, Humboldt and Mendocino counties may be said to have a monopoly of this wood, the first in commercial importance on the Pacific coast. Oregon, with her magnificent forests, has none; Puget Sound, with a lumber supply incalculable, has no redwood; nor does it grow anywhere on either slope of the Sierra Nevadas.

The redwood is a close grained timber, splits true, and is very light in color, like the eastern cedar. It works beautifully under the plane, and has the merit of retaining its place and shape without warp or shrinkage. Its durability is unquestioned. Hundreds of miles of redwood fences, built 20 years ago, are yet sound, and attest this fact. For fence posts and railroad ties it is the best wood known, resisting the action of both air and water with matchless durability.

Sonoma and Mendocino counties furnished the ties for the Central Pacific railroad. Every eastern train that crosses the Sierra rolls over the product of the forests of Sonoma. The redwood is also used for ties on the Southern Pacific, and ties from this county are now laid on the desert of the Colorado. They have gone further, having been shipped to South America for that wonderful road which leads from Lima, in Peru, to the summit of the Andes, 17,000 feet above the level of the Pacific. Henry Meiggs, who built the road, was once a mill owner in this county. He remembered the redwood and its valuable properties, and ordered from our forests ties for his railroad up the Andes. The redwood is a creature of the fog. During the summer months the trade winds blow along the north coast with great regularity. A dense fog banks up some miles from the shore; later in the day the wind increases, and the fog is driven inland. Detached masses first come in like flying squadrons, creeping through the foliage of the tallest trees, crawling over the hill tops, and down the opposite slopes, filling up the canons, and soon hill and valley are enveloped in dripping mist.

The foliage of the redwood possesses the peculiar power of condensing this mist and converting it into rain, thus supplying the roots which sustain the mighty bole of the tree with moisture during the long and rainless months of summer. The fog continues through the night and disappears with the sunrise. This irrigating process is repeated every day during the prevalence of the trades. Few persons can appreciate the grandeur of these redwood forests. Last summer the writer stood upon the summit of the coast range; to the northward lay a sweep of majestic forests unsurpassed on the continent—tier upon tier, range upon range of redwoods, until, 50 miles away in the distance, their green crests faded or merged with the horizon; and could we have compassed the outer bound of vision, beyond, to an equal distance, the eye would have been greeted by unbroken forests.

WOOL AND CLOTH DYED GREEN WITH PICRIC ACID.

By J. HAUSNER.

IN order to test grass-green military cloths as to their permanency, sample cuttings are treated with dilute hydrochloric acid of 1·0007 sp. gr.; also with dilute alcohol of 0·9714 sp. gr., at 75°. Most cloths stand the alcohol test, but are altered by hydrochloric acid, the cloth and liquid turning blue, a property which shows that the hydrochloric acid test depends chiefly on the blue contained in the green.

DESIGN FOR UPRIGHT PIANO.—*From The Workshop.*

Hydrochloric acid is colored by sulphate of indigo and by aniline-blue, but is not altered by vat-blue. It is easy to understand that dyers prefer to obtain light shades by using a more certain and simple method than the vat process, and it may also be supposed that, on the same grounds, the green dyeing by means of picric acid has mostly been combined with the modern methods of blue-dyeing. A series of experiments showed, however, that vat-blue woolen stuffs dyed green with a weak alcoholic picric acid solution remained unattacked by alcohol and hydrochloric acid, and were quite permanent after long exposure to the sun and rain.—*Dingl. Polyt. J.*

OLD CORKS MADE NEW.

MOHR recommends that the corks be collected and soaked in hot water. The following day they are washed repeatedly with pure water and soaked in a mixture of 15 parts of hot water and 1 part of hydrochloric acid. After a few hours they are taken out of this bath, washed well and dried; they then exhibit the appearance of new cork.—*Dingl. Polyt. J.*

ON THE MINUTE MEASUREMENTS OF MODERN SCIENCE.

By ALFRED M. MAYER.

Article XIV.

ON THE APPLICATIONS OF ROTATING MIRRORS TO THE MEASUREMENTS OF MINUTE LENGTHS, ANGLES, AND TIMES.

IV.—APPLICATION OF SAXTON'S COMPARATOR AS A THERMOMETER.

MR. SAXTON showed this application of his comparator more to set forth the delicacy of the instrument than to advocate its use as a measurer of temperatures. An example will give the reader an idea of the sensitiveness of the instrument to changes of temperature. A bell-metal rod of one yard in length having been placed on the instrument, I found that its increase in length, in heating it from 0° up to the boiling point of water, causes the 2,100 divisions of the scale to pass over the thread of the telescope. So 2,100 divisions of the scale correspond to 180° Fahr. Hence, 1° Fahr. corresponds to 11 divisions of the scale. But we can readily read to ¼th of a division; hence the instrument will show a change of temperature in the rod of $\frac{1}{44}$th of a degree.

In the above computation we have assumed that the length between the abutting-screw and the axle of the mirror has remained constant. This can only be the case when the beam on which the instrument is fastened maintains a fixed temperature. This beam, however, being of pine wood, has a very small coefficient of expansion, and if we should substitute for the above rod of bell-metal one having a slightly higher coefficient of expansion, the illustration, as above given, is correct enough for our purpose.

Saxton's Application of the Mirror to the measurement of the minute motions of suspended magnets.—It is well known that a suspended magnetic bar points in a northerly and southerly direction. But the magnet is never stationary, it is constantly turning one way or the other around its point of suspension. These motions of rotation are, however, minute, varying in amount with the latitude. In the northern hemisphere, the northern end of the magnetic bar, or needle, has its extreme easterly position at four or five hours before midday; thence it begins to swing with an increasing velocity, which attains its maximum nearly at the moment when the sun crosses the magnetic meridian of the place. One or two hours afterwards the needle comes momentarily to rest and then begins its eastward swing, and comes, with a slight secondary vibration, to its first position about sunrise, to begin again its daily oscillation. This arc of daily oscillation is small, only from five to twenty-five minutes of arc; and its extent changes with the seasons, being nearly proportional to the diurnal arc described by the sun. Thus, from Dr. Bache's observations at Philadelphia, the mean daily arc of vibration for the year is seven and one-half minutes; for summer it is ten and one-half, and for winter it is five and one-half minutes. The daily oscillation increases from the magnetic equator to the magnetic poles. On the equator it is only three minutes, while Dr. Kane found it over sixty minutes at Rensselaer Harbor, in north latitude 78° 37'.

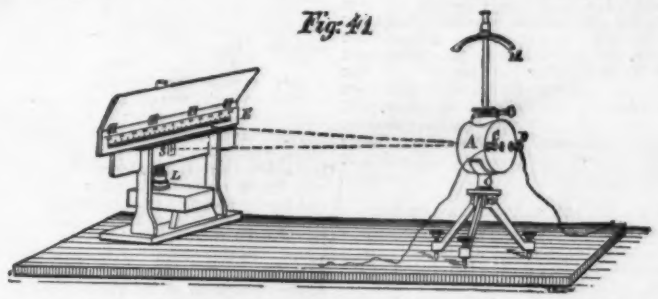


Fig. 41

The needle has also other motions; one of them occupies over 300 years, and the following is a short account of it: About 1620, it was discovered that the needle did not keep one line of direction even in the same place, but was slowly deflected year after year. Thus, it was found, that in the year 1580, the north end of the needle, at London, pointed 11° 15' east. In 1662, only 6° east; while in 1600 the needle pointed due north and south. Then in 1730 it pointed 13° west; in 1765, 20° west; in 1818, 24° 41' west; in 1850, 22° 30' west; in 1865, 21° 6' west. Here we see, in the needle, a most remarkable motion, governed by some cause, acting regularly through a long period of time, which, after having, for 158 years, given it a swing from the meridian to its extreme westerly position, is now slowly, year after year, throwing it to the meridian on its easterly swing. Thus, in about 320 years, it makes one oscillation; and what is yet more remarkable is this—it follows in its oscillation the same kind of motion as a swinging pendulum. The above figures show that it moves faster and faster, till it comes into the meridian, then that it slacks its velocity and gradually comes to rest at its extreme easterly or westerly position.

Yet another cause, apparently removed from the earth itself, affects the magnitude of the daily swing of the needle; which, strange to say, seems to depend on the condition of the surface of the sun. We owe this astonishing discovery to the labors of three men.

First, Counsellor Schwabe, of Dessau, Germany, began in 1826, daily observations on the number, size, and position of the spots which are nearly always visible on the solar disc. With an admirable perseverance, characteristic of his nation, he has kept these up for nearly 50 years. This long siege at last made the sun reveal the order of his freckled appearance. In 1850, Schwabe announced that the amount of spotted surface, which yearly appears in the sun, follows a regular law, going through its cycle in about ten years. Thus, in 1860, the number of spots visible was remarkable; but, in 1865, very few were to be seen, after this they became more and more frequent, until 1870, when they again appeared in profusion. About the same time that Schwabe gave this discovery to the world, Professor Lamont, of Munich, announced that the daily range of the needle's variation went through a similar cycle. Very soon afterwards, General Sabine, of England, discovered independently the same fact, which he deduced from magnetic observations, made at places as far removed from each other as Toronto, in Canada, and Hobarton, in Tasmania, and was thus led to refer the cycle to some cause exterior to the earth, and then pointed out the coincidence of the ten-year solar spot cycle, and that of the magnet's daily range of deflection. This amount of daily deflection is four minutes more during the year of the greatest number of spots than during the year of the least amount of spotted solar surface.

And, thirdly, the needle is subject to unruly vibrations, or tremors, coming at unexpected times, and affecting, simultaneously, magnets suspended at great distances from each other. These disturbances of the needle are often, though not always, accompanied by outbursts of the aurora polaris, and it has been observed that the flashes and lateral movements of the auroral columns are always accompanied by simultaneous deflections of the suspended magnet; and what is more remarkable is the fact that the examination of extended series of observations on auroras has evolved the remarkable fact that they obey periods of maximum and minimum frequency, coinciding with the cycles of the solar spots and of the mean daily range of the magnet's vibration.

The present direction of researches in these interesting problems is to find a relation of concurrence between the sudden changes on the sun, now so readily visible by the aid of the spectroscope, and sudden deflections of magnets suspended at many points on the earth's surface. Professor C. A. Young and others have made observations which show a close physical connection between extensive actions in the solar chromosphere and sudden deflections of magnets on the earth; but the observations are not yet extended enough to surely establish such physical connection, though all will admit that there is great probability in its existence.

Daily and cylical motions and perturbations similar to those above described affect the "dipping-needle," which is a magnetic bar supported on an axis passing through its center of gravity and at right angles to the magnetic meridian.

The account we have given of the minute but constant and complicated motions of magnet shows the importance of having some simple and precise means of observing and measuring these motions, so as to collect continuous observations to serve in the discovery of the causes and laws of terrestrial magnetism. In 1825, Saxton fixed a plane mirror to a suspended magnetic bar, and also applied one to the axis of a dipping-needle, and observed the motions of these bodies through the motion of a beam of light reflected from their mirrors. Several years subsequent to this invention of Saxton, Poggendorff and then Gauss applied the principle of reflection from mirrors to the measurement of angular motions. Unfortunately, Saxton did not connect his instrument with any research on magnetism, and thus the credit of this capital improvement in the art of minute measurement is generally given to Gauss or to Poggendorff.

The advantages of this system of observation consist in the apparatus being far less costly than the instruments with divided circles, while at the same time the mirrors allow of the measurement of very small angular quantities; also, the observation may be made at a distance from the magnets; indeed, if necessary, the observer may regard the motions of the magnet through telescopes placed outside of the room containing the instruments.

One of the chief merits of this invention is that it led Brooke, of London, to replace the plane by spherical mirrors on which pencils of light fell from holes in metal chimneys surrounding gas flames. These diverging pencils of light were converged by the mirrors into bright dots of light on revolving cylinders covered with paper photographically sensitive. On these papers the dot makes a trace, as the cylinder revolves once in twenty-four hours; and as the motion of the dot of light is parallel to the axis of the cylinder, it follows that the magnet leaves its trace on the paper in a sinuous line. The paper is removed once a day, and the trace is fixed by removing from the paper the silver salt which has not been acted upon by the dot of light. Thus, every day, a sheet with a permanent record is obtained on which the magnet has recorded its position for every instant. This was an accomplishment needed for the further advance of the science of terrestrial magnetism, and absolutely necessary in order to detect any physical connection which may exist between changes in the solar chromosphere and simultaneous changes in the magnetic condition of the earth.

The invention of Saxton is also the father of a well-known instrument which uses a beam of light reflected from a curved mirror to measure the deflections of a magnetic needle of a galvanometer. A similar instrument is used to receive the signals passed through submarine telegraph cables. The description of this galvanometer will also serve to give an idea of Brooke's application of curved mirrors to the declination and dipping-needles. Figure 41 is a perspective view of Sir William Thomson's galvanometer. A delicate magnet made of a short piece of watch spring is cemented to the back of a small concave silvered-mirror, and the mirror is suspended by a single silk fibre in the interior of a coil of insulated wire contained in the cylindrical box A. A circular hole passes through the box and coil, and in the centre of this hole is suspended the mirror. The cylindrical box is supported on a tripod with levelling screws. Above the suspended magnet slides a large curved magnet, M, on a vertical rod. The magnet can also rotate around the rod as an axis. The poles of this magnet, called a damping magnet, are turned in the same direction as the poles of the small magnet in the interior of the coil. At C and D are shown the binding-screws to which are attached the ends of the coil of wire in the box A. Wires are shown, leading the current of electricity to be measured to the binding screws C and D. Behind a board is placed a lamp L. The light from this lamp passes through an adjustable slit at S and entering the box A falls upon the concave mirror, which reflects and converges the rays to an image of the slit on the divided scale E. Any motion of the magnet or mirror produced by the passage of an electric current through the galvanometer is shown by the motion of the band of light over the scale; and the angular motion of this spot of light is double the angular motion of the mirror.

Saxton's application of a rapidly revolving mirror to the analysis of the rapid vibrations of a luminous body.—Professor Joseph Henry, in his biography of Saxton, says: "One of his modifications of the revolving mirror consisted in fastening obliquely to a revolving axis, a small mirror on which, if a ray of light was thrown from any source, and when a sufficient velocity was given to the mirror, a large circle of light would be projected on a prepared screen or on the ceiling of a room. A rapid revolution was given to the axis by a train of wheels driven by a coiled spring, and with this instrument rapid fluctuations in the intensity of a light could be readily observed. When the ray of light was from charcoal points, forming the poles of a galvanic battery, the circle of light exhibited a mottled or dotted appearance, indicating a rapid alternation of intensity in the electric discharge."

This apparatus of Saxton's has been the precursor of many similar instruments used by various observers in the analysis of the nature of such luminous bodies as the electric discharge or vibrating flames. A few years ago, König, of Paris, introduced the use of the revolving mirror with marked effect in connection with his vibrating manometric flame. This flame is formed by a small jet of coal-gas which issues from a box, one side of which is formed of thin rubber. The sound-vibrations falling on the rubber caused the flames to vibrate, and the nature of these vibrations was detected by the serrated appearance of the flame when viewed in a revolving mirror. It is evident that if the flame is at rest it will appear drawn out into a band of light, with smooth borders, when viewed in the revolving mirror; but, if the flame vibrates, this band of light will at once appear with a deeply serrated top border.

NEW ELECTRIC LIGHTS.

AN examination of the voluminous records of the British Patent Office discloses the fact that the activity in a particular line of invention periodically waxes and wanes. After slumbering for a number of years the problem of procuring effective electrodes for the production of the luminous electric arc has of late been revived, and with a success hitherto unattained. The immediate cause of this has probably been the recent improvements of magneto-electric machines, culminating in the Gramme and the Siemens machine. An efficient source of electricity for the production of the light having been supplied by these and other machines of a similar kind, a stimulus was given to the invention of electrodes or *wicks* which would employ the magneto-electric current to best advantage in giving out light. The old faults of the carbon points had never been quite overcome. The manufacture of the points from soft wood charcoal, fine coke dust, lampblack, calcined sugar, tar, resin, or mineral oil, etc., had done much to render their consumption steady and uniform; and the regulators of Serrin and Dubosq had very successfully overcome the the widening of the luminous arc by the wasting of the positive electrode. For large fixed lights with several sets of luminous points, such as are employed as beacon lights on land or at sea, the ordinary carbon points thus improved answered very well, but for the purposes of general illumination they are still defective. To give a light suitable to a room or a hall the points require to be small, and any inequalities in their action are very discernible in the light. One great difficulty to be overcome, too, is the division of the light. How to cause the current from a powerful magneto-electric machine to produce a number of separate small lights, such as would be essential for the lighting of streets or buildings? If the different lights were all joined up "in circuit," and the current sent through the whole series one after another, the break-down of any one of the series would extinguish the whole and plunge the street or building into darkness.

During the last thirty years there have been many attempts made to secure good electrodes for the electric light as well as devices for adjusting them. Electrodes of spongy platinum, palladium and iridium have been used. Another plan was to make the positive electrode a fine stream of mercury flowing from a funnel and breaking upon a negative electrode of carbon or platinum placed underneath. An objection to these metals was the colored lights they produced owing to incandescence of their vapors in the arc. The carbon electrodes were given divers shapes, and various combinations of carbon and metal electrodes suggested. For instance, it

was proposed to use bar electrodes emitting the light from their sides, and also to fuse iridium between two carbon electrodes. An ingenious plan for getting a steady light was proposed by Mr. Harrison in 1857. It consisted in giving a rotary motion to the positive electrode and pointing the negative electrodes at right angles to it, and giving the latter a motion of translation, so that fresh surface of the positive carbon was always appearing in front of the negative carbon. A similar idea was again patented in 1874 by Messrs. Wildman and Whitehouse. About twenty years ago there was a great deal of activity in this direction, but up till quite lately the usual carbon points have always been fallen back upon.

Within the last five years, however, two notable new lights have made their appearance, namely, the lights of Lodighin and of Jablochkoff. M. Alexandre Nicolaevitch Lodighin is a Russian engineer of St. Petersburg. His plan was first publicly tried there in 1873, and patented in England in the previous year. It is designed to facilitate the use of the electric light for general lighting purposes. The great defect of the ordinary carbon points is the flickering of the light caused by the consumption of the carbon points, a great portion of which is due to the combustion of the points in the air. M. Lodighin's plan is to employ not two but a single stick of carbon, inclosing it in a hermetically sealed glass chamber from which all air has been exhausted, and an azotic gas which does not combine with carbon at a high temperature, such as nitrogen, let in. When a current from a magneto-electric machine, such as Wilde's, Gramme's, or Noble's, is passed through this carbon, it gradually gets

heated to a white heat, and emits a brilliant, and at the same time soft and steady light. Fig. 1 shows the form of the carbon used; the light is given off at the narrow central part. The advantages of this plan are that there is a continuous circuit, so that any number of lights may safely be joined up in series to form one or more lamps. The lights can be made as small as desired, the flame is continuous and not injurious to the eye, the cost of new carbon points is saved, and the current can be strengthened or weakened at will very easily. It burns equally well under water, and would be very useful for illuminating dangerous mines, there being no fear of explosion from it. One magneto-electric machine, driven by a 3 horse power engine, generates a light equivalent to many hundred lanterns, and the light can be easily divided up into smaller ones. There was one defect in M. Lodighin's original light which has been remedied by M. Kosloff, of St. Petersburg. The unequal expansion of the metal holder of the carbon and the carbon itself caused the latter to split and give way. The metal also fused, and sparks passed between the carbon and the expanded sockets. Kosloff fixed the carbon on insulating supports of china, clay, crystal, etc., and connected it in circuit by wires. The improved light of Lodighin and Kosloff was first tried in London in 1874, and was very successful. It was awarded the Lomonossow Prize by the Russian Academy of Sciences.

But the "electric candle" of M. Jablochkoff has, for the nonce at least, quite cast Lodighin's light in the shade. It appears to be one of those lucky inventions crowning a long series of more or less unsuccessful ones in the same direction. In the electric candle the two carbon points are not dispensed

with. They are placed side by side and separated from each other by a slip of an insulating substance such as porcelain, brick, magnesia, but preferably kaolin or pure clay. One of the points is a little longer than the other, and may also be stouter. The positive current is passed down the longer carbon, and leaps across the air space to the shorter carbon, forming the luminous arc at the point of the candle. Such an arrangement of the points is shown in Fig. 2. It is called a candle because it can be burned upright in a support like a candlestick. The kaolin plays an important part besides insulating the carbons from each other. It becomes incandescent, emitting a beautifully soft, steady light, and melts away like wax at the same rate as the carbons, just as a candle is consumed with the wick. No mechanism is required for the adjustment of this electric candle. The discovery that kaolin becomes intensely incandescent under the current also enables M. Jablochkoff to dispense with the carbon points for small and medium lights. He made the discovery, we believe, in studying the effect of a succession of sparks from the secondary coil of an induction machine on refractory bodies. He first heated a plate of kaolin to incandescence, but did not fuse it. Then he led the induction current along the edge of the plate by means of a more conductive coating. This caused the edge to fuse and emit a splendid band of light, as soft and steady as any known source. This discovery disclosed a feasible system of lighting towns and dwellings by dividing the electric light. It would be possible to generate lights of all sizes by means of the kaolin; and by employing a number of separate secondary coils, one to each candle, for one primary, the current could be simply and effectively divided. By having the carbon candles for large warehouses and public buildings, and a very simple pincher holding a kaolin wick for offices and corridors, and by having separate secondary circuits to each set of lights, electricity could be laid on for illuminating purposes as easily as gas. The passage of the current through the kaolin makes the circuit complete as in Lodighin's plan, and a number of lights can be joined up in the same circuit, so as to form a set of luminous centers. As many as eight candles have been kept steadily burning in the circuit of an ordinary magneto-electric machine. Some of the principal halls of the Louvre have been lighted by the candle in this way. MM. Denayrouze and Jablochkoff have, we are told, easily obtained fifty luminous centers of various intensity in graduated series, the weakest yielding a glow equivalent to one or two gas burners, the strongest equal to fifteen burners, from one current. By employing a magneto-electric machine giving alternating currents the current interrupter and condenser of the induction coil may be dispensed with, the alternating currents being simply passed through the primary coil. Again, by employing a magneto-electric machine yielding several powerful intermittent currents, the induction coil with its several secondary coils may be dispensed with altogether, and the magneto-electric currents passed through the candles. This power of being able to divide up the current so as to have several circuits with several candles of various degrees of illuminating effect in the same circuit, or only one, gives to electric lighting the convenience of gas. It cannot be so expensive as gas, and it must be far less pernicious and dangerous than gas in a house. The lights require to be shaded by ground or opal glass shades to diffuse the rays. The consumption of kaolin is very small. It is said that a piece the length of a centimeter will last ten hours.

The recent public trials of Jablochkoff's light at the West India Docks have been recorded. The first was unsuccessful owing to some defect in the magneto-electric apparatus. In the second and successful trial, a large tent inclosing 900 square feet was illuminated by four candles fixed on lamp-posts, and surrounded by globes of opal glass. At twenty or thirty feet from the lamps very faint pencil lines could be distinguished on paper, and small print read at a considerable distance. When common candles were substituted for the electric lights the effect was most marked, and the light a sickly yellow. In the electric illumination the most delicate colors retained their purity of tint. A warehouse was also lighted up by three naked candles, and a ship lying alongside a wharf by two, in order to show that lading or unlading could be carried on at night.—J. MUNRO, *Nature*.

CURIOUS ELECTRICAL EXPERIMENTS.

A FURTHER series of experiments with high tension electricity from his secondary batteries, has been described by M. Planté to the Paris Academy. They have a bearing on the phenomena of globular lightning. He used batteries, each containing 40 couples (= about 1,200 Bunsen elements). The positive electrode was plunged in distilled water, and the negative (platinum wire) brought near the surface. A column of water having been interposed in the circuit to prevent fusion of the wire, a small ovoid globe of fire (8 to 10 mm.) appeared, with luminous blue points in concentric circles where it was in contact with the water-surface. These presented curious changes, performing gyratory movements, describing spirals, etc., and ending with concentric blue rings. On examining minutely this form of spark, it is found to be a kind of voltaic *aigrette*, and the luminous threads are in a state of constant agitation. When the metallic electrode is positive, and the distilled water negative, the spark has again an ovoid form exteriorly, but the middle is traversed by a cone of violet light. By oscillating the electrode suspended from a long pendulum, the motion of fire balls on a surface may be closely imitated.

[Continued from SUPPLEMENT No. 99.]

THE GLANDULAR ORIGIN OF CONTAGIOUS DISEASES.

The germ hypothesis fails, however, on other grounds than the clinical. If it were true that living germs possessing an independent growth and vitality enter the animal body, that every disease of a communicable kind is due to its own external living germ, and that the germs continue to multiply and increase by an independent action of their own; if this be indeed true, why do the germs after a certain time cease to multiply and allow the sick person to recover? Why do they not go on multiplying until the person is infested in every part and fatally stricken? Who would get well from a disease due to living self-propagating contagions? Again, who, if the hypothesis were true, would escape fertilization? A general fertilizing diffusion of self-propagating matter in minute invisible form entering the body as the air may enter could hardly be expected to select a small minority of a population, and if it did so at the first, why should it do so when it had seized upon many centres in which it could increase? But the history of all the communicable diseases shows that each epidemic affects individuals individually at different periods in the course of the epidemic according, as a rule, to exposure to the infected, and that the period of the disease is limited by a development and a course rendered in certain periods of time.

I need hardly add in objecting to this germ hypothesis, because the fact is admitted, that not only has no one ever seen a germ of disease, but that no one has ever traced any order of germination in relation to any of the communicable diseases. When a really living self-propagating thing goes through its phases of life and action, like, for example, the yeast growth, we can trace it through its course of action on organic substances, and can study its effects, the changes it produces and the products of such changes. In the epidemic diseases we have no such guidance, no trace of it. Their phenomena, indeed, are opposed to the idea of self-action of a foreign vital material.

LATER OBSERVATIONS ON THE GLANDULAR THEORY.

I turn again to a brief review of the glandular theory of the origin of the contagious diseases, and of the advances I have made in support of that theory during the period of the past ten years.

In that time I have seen no reason to change my views on the subject of the glandular origin of the communicable diseases. On the contrary, every new observation has tended to confirm it and to make as I think the demonstration of its truth the more definite.

In continuance of observation I have noted that the number of the distinctly communicable diseases is closely related with the number of secretions. The poison of hydrophobia is from the salivary secretion; of diphtheria from the mucous glands of the throat; of scarlet fever I believe from the lymphatic glandular secretion; of glanders from the mucous secretion of the nasal surface; of typhoid from the mucous glands of the intestinal surface; and so on. In some instances the blood itself is infected, and the corpuscular matter becomes the seat of the catalytic change.

A second point which has occurred to me is that the matter or particle which sets up the poisonous action, instead of being living matter, is matter actually dead, and that its effect for evil depends, in fact, upon its being dead. I mean that the dead particles of organic matter in contact with living are the cause of the physical change which transforms the new particles of secretion into poisonous particles as they are brought up to the infected surface to be influenced by the infection.

On the ground that the poisons are always of glandular origin I have been led to the conclusion that under certain influences affecting glandular action the poisons may be made to originate directly through nervous impression without the necessary intervention of an infecting particle. In many epidemics it is common to see a number of examples of the prevailing disease the origin of which is traceable only to fear or anxiety. We call these nervous cases, and we try to define them as such and as distinct from cases due to contagion of a direct kind. But the symptoms are the same as those which follow actual contagion, and in epidemics of cholera they take even a fatal character. My theory explains fully the reason of this. It indicates that an extreme nervous impression acts on the glandular nervous supply, paralyses the glandular function, and thereupon produces the same phenomena as is produced in other instances by the action of a specific poison.

The theory in this manner accounts for the origin of an epidemic disease from an impression made on the nervous system without the direct contact of poisonous matter, as well as for the after-propagation of the disease by distribution of poisonous particles when that is communicated from an infected to a healthy person. It accounts equally well for the production of disease and of a poisonous glandular product under conditions of starvation and cold, by which the nervous tension is reduced. Again, it accounts for the production of disease and of a poisonous glandular secretion under special atmospherical conditions in which the activity of the atmospheric oxygen is reduced in sustaining power.

It has occurred to me further, as a result of the study of the action of the poisonous particles, that when they are brought into contact with the secreting surface, their action towards the body at large is, in the first instance, directly on the nervous fibre. The poisons act in the first instance as irritants on the peripheral nervous surface, and their effect may, I believe, extend particle by particle, as by diffusion, through the whole length of the nervous cord to the nervous centre. I have no doubt this is what slowly takes place in hydrophobia. I believe this is what takes place in diphtheria when paralysis is the sequel of the acute symptoms of the malady. I believe the same mode of progression of the poisonous influence is what happens after inoculation with matter of small-pox, that the severe nervous symptoms which mark the onset of that disease are due to the extensive injury inflicted on the nervous organization, and that the diffusion of the eruption over so wide a surface of the skin and mucous membrane is the reflex on the peripheral nervous surface from the nervous centres.

It is worthy of special notice in connection with this part of my subject, that in the communicable diseases attended with an eruption on the skin or nervous surface, the eruption, as a rule, takes a circular form. If it be a point of vascular blush, a patechial spot, it is a rounded spot; if it be a pustule, it is rounded; if it be a more diffused rash, it commences in centres which are rounded points. This appearance is an indication of nervous injury. The rounded surface is the radius of injury done to the nervous supply of that part. It is a paralysis of the centre of nervous distribution over the affected part. My researches on the influence of extreme cold on nervous function is strikingly illustrative of this fact. They suggest that the nervous impressions sent from the centres to the peripheral surface when they reach the peripheral surface, as on the surface of the skin, spread out like circling waves, just, in fact, as water spreads out in circles on a pool when a stone is made to impinge on the surface.

Some other recent investigations on the mode of action of the poisons of the communicable diseases has led me to suspect the source of the symptom which is so common to most of them, and which is known as the attendant fever. The fever is of three kinds: primary, reactive, and remittent. The primary fever is that which precedes and attends the eruption of an eruptive disease. The reactive fever is that which succeeds the extreme collapse of an acutely exhaustive disease like cholera, or an exposure to extreme cold. The remittent fever is that which succeeds upon an acute form of disease, and indicates either that there has been secondary absorption of matter from an abraded surface in contact with poisonous substance, or that some fibrinous or pustular matter has formed within the body, as it were, and become a new and permanent centre of infection.

The first of these forms of fever is, I believe, due to the impression on the nervous centres by the poison in the manner I have described above.

The second, the reactive fever, is, I believe, due to the same action as that which locally may be induced by extreme cold, viz., by an influx of blood into vessels that have been paralyzed, and by a rapid radiation of heat from extensive surface of blood.

The third form of fever, the remittent, has an origin, I believe, specifically its own. I have found that pustular matter and all secretions containing fibrinous or cellular structure have the property, by their presence, of liberating oxygen from solution. This extends, as I have found, to blood charged with oxygen, and I am led to the inference that when there is an absorption of such matter into the circulation it causes an undue liberation of oxygen with a quicker combustion, a fever which lasts until the exciting matter is itself destroyed and eliminated, and which does not recur until there is re-absorption of more of the exciting agent. In this physiological mode I should explain all the phenomena of the remittent attack, the cold stage incident to the absorption of the exciting matter; the hot stage incident to the period when, by its presence, the exciting matter is setting free excess of oxygen; the sweating stage when, by rapid elimination through the sweat glands, the equilibrium of temperature is restored.

The study of the glandular theory of the communicable diseases has suggested to me another thought which observation of the diseases fully confirms, viz., that these diseases, like all which have their root in nervous derangement, present a distinct heredity. The impression of disease made on a nervous centre is transmitted. There can be no doubt as to transmission of tendency to particular communicable disease. Any physician in full practice can find any amount of evidence on the fact by simple natural inquiry. Typhoid fever is clearly a disease possessing hereditary transmissible quality. Diphtheria is the same. Scarlet fever is the same, and small-pox I should suspect was once almost universally so characterized. These facts alone, one of them alone, is sufficient to stamp the origin of the communicable diseases as from the animal body itself. It is certainly one of the best of proofs of the truth of the theory of the glandular origin of the poisons. It will be seen at once, by those who look with sufficient patience, that the mode of connection of the diseases in hereditary line is the same as that which connects hereditary qualities of every kind, physical type, mental type, all else that blends many individualities into one family.

Lastly, the study of the glandular theory of the communicable diseases enables me to offer the most rational explanation of the phenomenon of non-recurrence of the diseases after they have once attacked a person susceptible to them. It is well understood that, as a rule, a person who has been affected by a communicable disease is not affected a second time. To this rule there are many exceptions, but on the whole it holds good. On my theory the reason of the phenomenon is simple enough. They who are susceptible are born with a nervous impression tending to the production of glandular secretion easily changed into poisonous secretion under the direct action of contact with poisonous matter, or even under the influence of a central nervous depression, whereby the glandular function is deranged. But when such a person has passed through the ordeal the tendency, for a time at least, disappears owing to the complete modification of glandular function that has been induced, to the free elimination that has been established, and probably to the change in the nervous matter itself that has resulted from organic modification. Hence the organism becomes susceptible for a time, and if the tendency be not intense that time may mean the whole of the life. Indeed, as life advances and nervous susceptibilities derived directly from ancestry lapse into individual self-sustained susceptibilities, these tendencies to disease subside as a general fact, and lose their activity if not their existence.

I turn, in conclusion, to consider for a moment, from the view of the glandular theory of the communicable diseases, the practice that is suggested for the suppression of the plagues of mankind.

It will be seen at once that on this point nothing can be wider than the distance between the idea of contagium as a living self-productive thing, reproductive and independent, and the theory of the production of the contagium in each affected person by the force of production of his own secretion. The latest and one of the ablest advocates of contagium vivum, Dr. W. Roberts, says, respecting contagium:—"We know of nothing that exhibits the phenomena of growth and multiplication except a thing possessed of life."

I admit that readily, but my argument is that the process of secretion is a process of life, and that this living process, perverted as I have described, is amply sufficient to account

for the production of all the poisons that exist to cause the communicable diseases, that it accounts for the number of these diseases, and more, that it accounts for the limitation of the number.

THE GLANDULAR THEORY IN ITS APPLICATION TO PRACTICAL SANITATION.

The practical usefulness of the theory, however, consists in its direct application. If the contagium vivum view be true, if the air around us is charged with invisible germs which come from whence we know not, which have unlimited power to fertilize, which need never cease to fertilize and multiply, what hope is there for the skill of man to overcome these hidden foes? Why on some occasion may not a plague spread over the whole world, and destroy its life universally?

My theory presents an altogether different aspect. I say to living men and women, it is you who are the producers of the communicable diseases, or if it be not you yourselves it is one of your lower earthmates in creation, some domestic animal that shares with you the power of producing a poisonous secretion and of giving a hereditary stamp of production to such poisonous product. I look on the man or animal affected with a contagious disease as one precisely, for the time, in the position of the cobra or other animal that naturally secretes a poison, and recognizing this fact I see at once that the danger is all but limited to the persons affected.

Isolate that person from the rest of mankind, take care that his secretions, volatile, fluid, or solid, do not come into contact with the secretions of susceptible healthy persons, and the danger is over. With the recovery of that person, that is to say, with restoration in him of a natural secretive process, the poison is destroyed; or should he unfortunately die, then with the death of his power to produce further secretion the danger is over, unless from his dead body some of the poison formed before the death be actually carried away to infect. In a word, if my theory be true, we sanitarians have complete mastery over the diffusion of the poisons of all the communicable diseases. We have to keep steadily in view that the producing and reproducing power is in the affected body, and we can, even with our present knowledge, all but completely limit the action to the propagating power of that body—its power, I mean, of secretion and diffusion of secretion.

Beyond this, if the theory be true, we must expect, as we reduce the communicable diseases of one generation to reduce tendency to them in the next generation, so that in time the heredity to particular spreading disease shall be thoroughly wiped out.

The theory suggests a profitable line of research on the subject of the production and reproduction of some of the poisons by the inferior animals and their transmission in that course to man. It brings all the inferior animals, in respect to their health and comfort, under our special human care, not only for their sakes, but for our own self-preservation.

Finally, the theory suggests to those who are engaged in treating diseases of a communicable kind the best means of arresting the progress of a communicable disease even when the phenomena of it have been developed in an individual. It leads us physicians to take a precise view, in each such case, of the nervous and glandular processes that are out of the natural order of work; it suggests to us to seek for remedies amongst chemical agents which affect special secretions; and it shows us how to place the sick under such conditions that the secondary absorption of their own poisonous secretions—that deep absorption which, according to my experience, is the actual cause of death in the great majority of cases of contagious disease—may be avoided.

In every direction, in fine, in prevention and in cure, the glandular theory of the origin of the communicable diseases opens practical work and hopeful work.

I have for some time past sought for a favorable opportunity of once more putting forward this theory of the natural origin and cause of the communicable diseases of men and animals. The present is opportune to the fullest degree, and therefore I have seized on it. I am too earnest after search of truth for its own sake, too certain that in science everything false must fall, and everything true must remain, to feel any sense of anxiety as to the fate of my simple theory, by the side of the doctrine of a living contagium. If my doctrine be as true as I believe it to be, it will live, whatever force be arrayed against it. If it be not true, I would be of the first to welcome its end, and to hail the ascendency of what is absolutely provable and certain on the momentous questions that have occupied our attention.

Meanwhile, I know I could not do a better thing for my own views than submit them once more to the public eye through the audience which has now so attentively listened to the argument.

AMERICAN vs. FOREIGN DENTISTRY.

IN a paper read recently read before the New York Odontological Society, Dr. W. St. George Elliott said:

Six years' experience in foreign lands, where nine-tenths of those who applied for dental services had been the patients of English or Continental dentists allows me with truth to say that I never saw a good gold filling made by any one who had not received his instruction from America, or from an American. I do not state that no good fillings are made by our honored brethren abroad, but that it has not been my good fortune to have met with them. The extreme Eastern field, that is, China, Japan, Malayan Isles, Siam, etc., is now fully occupied by a force of seven, of which number six are American, all proficient in their business; in India there are some fifteen, only one being an American; and while he sustains the national reputation, the others are no worse than those found on the Continent. Personally I did not have the opportunity of examining very much of the work done; I was informed, however, by one who I think might be considered representative, that none of his co-laborers in that field made much effort to save teeth. Extraction and artificial work, with some amalgam, composed their repertoire. Subsequently I found the same condition of affairs in Europe. In this brief statement of the character of the service rendered abroad we find our reasons for thus bringing before your notice the fact that lack of skill, and not want of knowledge, is their deficiency, combined with a non-recognition of what is attainable by skillful manipulation, with perhaps a lack of ambition to excel in mere skill, and a suspicion that there is not that fraternal sympathy that is so conducive to unity of effort. You are all aware of what has been done for dentistry abroad. Her books and papers enter into almost every field of inquiry. To Germany and England will we ever be indebted. They have done more, vastly more, towards elucidating complex pathological and physiological problems than have we. It is my conviction that we may spend years in investigating questions in microscopic anatomy; we may attain world-wide celebrity as authors, and our names be handed down from generation to generation, and yet if we have not skill we are not good dentists. We may be able to recognize species, families, etc., by peculiarities in their respective teeth, and have a clear insight of the formative process, yet this knowledge will not enable us to put in a good filling. We have not a countryman practising abroad who can at all compare in professional mental culture with many about him, and yet the name of an American dentist carries with it its synonym—skill. Far be it from me to boast of our professional status, but in bringing before you this question, "What gives us our position abroad?" I beg your recognition of the means that have made us what we are. With your permission I will illustrate how little is thought of skill in London. A gentleman residing there, and whose name is familiar to us all, and who has done much for our advancement, when speaking of filling, remarked, "Why, this stopping of teeth is work for a mere mechanic. I employ assistance to do that, while occupying myself with more professional matters."

THE CABLE SPLINT.

By CHARLES F. STILLMAN, M. D., House-Surgeon St. Francis' Hospital, N. Y.

WHILE treating a fractured acromion process in March, 1877, the inability of any splint then in use to retain the fragments in apposition, led me to devise the apparatus now to be described; and the success attending its application to that fracture, and also to fractures of the clavicle and humerus, has led me to place it before the profession.

The splint is constructed as follows: After approximation of the fragments, the arm is encased to the axilla with plaster of Paris bandage in the usual manner, as shown in Fig. 1.

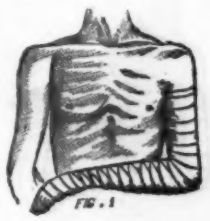


FIG. 1.

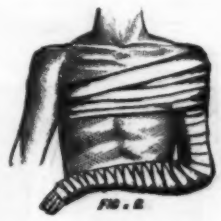


FIG. 2.

The next step consists in passing folds of the same bandage around the chest, covering the side of the shoulder, as in Fig. 2.

A shoulder-cap of good thickness is then formed of strips of the same, bound down by transverse chest bands, as in Fig. 3.

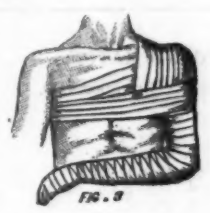


FIG. 3.

FIG. 4.

Thus far the apparatus does not differ materially from those now in use—the suspension of the arm in a sling usually completing it.

At this stage of the process, the *cable*, which cements the various parts together, is formed.

A roller of plaster bandage, from three to five inches in width, and of good length, is selected.

This is laid over the shoulder as far back as the spine of the scapula, and brought forward and downward *behind* the wrist, around which it is wound several times to afford as broad a base as possible, and passed *anteriorly* back over the shoulder to the starting point (see Fig. 4), where it is bound down by a turn around the chest, and again brought forward to the *front* of the wrist, under which it passes.

In returning to the shoulder it is *wound tightly* around the three slips already passed, thus forming the nucleus of the cable (see Fig. 5).

Upon reaching the chest band, the bandage is passed around that until the cable is again reached (see Fig. 6), which is once more wound to the wrist, after passing around which the bandage is returned to the shoulder in the same manner, and again brought around to the cable, which is once more wound as before.

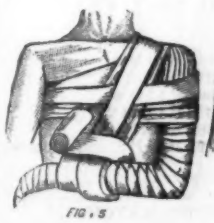


FIG. 5.

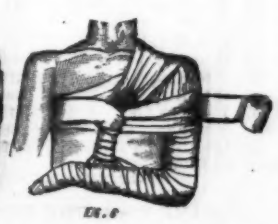


FIG. 6.

By repeating this winding process a number of times, a plaster cable is produced of great strength and intimately incorporated with all parts of the apparatus, binding and solidifying it in a manner which prevents all disarrangements of the parts covered (see Fig. 7).

ADVANTAGES OF THE CABLE SPLINT.

1st. Perfect immobility.

The cable may be grasped and shaken rudely without giving pain to the patient or disturbing the relations of the parts beneath.

2d. Ease of application.

3d. It does not constrict the neck, as does the ordinary cloth sling, the weight being borne by the shoulder and upper part of the chest.

4th. It prevents the leverage outward of the arm upon the shoulder, which is entirely obviated by any other apparatus now in use.

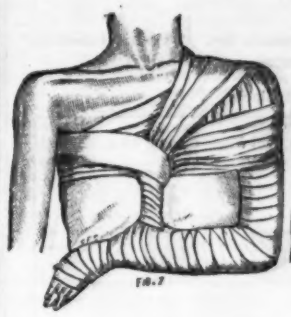


FIG. 7.

FIG. 8.

USES.

1st. In fractures of the clavicle, scapula, and humerus.

For the first time the shoulder should be held upward and backward during its application.

2d. For insuring rest after dislocation of the elbow or shoulder-joints.

3d. For disease of the elbow or shoulder joints. For the former the splint is applied as in Fig. 8, and possesses the advantages of securing perfect freedom from motion, and yet leaving the affected joint open for inspection and dressings.—*Medical Record.*

HOW TO PROMOTE HEALTH AND SKILL.

THE following excellent suggestions were lately given by Dr. W. St. George Elliott in a paper read before the New Odontological Society:

Dr. Marion Sims, when asked on one occasion what was the secret of his success in practice, said, "I owe all I am to these fingers; without the skill to perform I would be nothing." The late Dr. Bedford always took occasion during his course of lectures to call attention to the great necessity of digital skill in his department of medicine, and frequently expressed his ability to diagnose any uterine disease by the mere touch.

What are the means at our command by which we may attain greater proficiency in this matter? First in importance is physical education; for manifestly if we are dyspeptic, feeble, or chronic sufferers from rheumatism, we cannot in the very nature of things have that command over our muscles which we should have. Every effort must be made to develop physical strength; not that our calling necessitates strength above the average, but the very highest order of muscular control is almost imperative. This control must not be weakened by systemic disease or debility. As a means towards this end, allow me to suggest the regular use of the so-called Health Lift. Two rings fastened to the floor, with ropes and handles attached, accomplish all that the more expensive machines can do; although to some it may be a satisfaction to know how many pounds can be raised, or what may be the rate of improvement. Perhaps next in importance is horseback exercise; these two means, together with a diet adapted to the digestive powers of the individual, will accomplish all, or almost all, that can be done. I speak advisedly on this matter. Three years of inconvenience, not to say suffering, taught the writer that his appetite was greater than his digestion, or rather that the food taken into the system was greater than that required to sustain the physical strength called for in the exercise of his daily duties. When the cause was discovered the remedy suggested itself.

Should there be no necessity for physical culture, it were well that the muscles of the hand be well exercised and instructed. To this end pianoforte manipulation, drawing, target-shooting, etc., will be found useful; but a matter of much importance, and one very generally ignored, is the proper development of the powers of the left hand. Anatomy teaches us that it is the equal of the right, but how unimportant are its duties! The writer has derived much benefit from the practice of writing with the left hand, which practice has enabled him at times to make use of two pluggers at the same time, struck alternately by the mallet, as well as to place the gold *in situ* with the left, while the right is fully occupied with the instrument. Drawing circles on the wall at arm's length gives practice not only to the hand, but teaches steadiness to the arm. Of course it will be recognized that by actual practice at the chair we receive most of our digital education; but we must not forget that where there is no ambition to excel there will be no realization. "Good enough" has kept many down who were capable of better things.

We should cultivate the habit of order as the handmaid of skill, not only in the general arrangements and condition of one's professional appointments, which should be neat but not gaudy, but also in that of our instruments and appliances. It is unnecessary for me to mention the disadvantages labored under when for some special form search is made under a pile of soiled and broken instruments.

Skill should always be assisted by the use of every appliance proved to be useful; for manifestly he who does not make use of these things adds to the difficulties of the situation.

While all may admit the value of great command over the fingers, how few will acknowledge that their manipulation might be improved. Unskillfulness is the weakness of our neighbor, but never of ourselves.

But not only is this talent far below what it should be, but a deplorable want of order and system is visible throughout the profession. Not ten per cent of our brethren have any regularity either in their manipulation or in their instruments and appliances. To be sure, it is just as true out of the profession, the mechanical trades being sad illustrations of "how not to do it" or where not to find it. Whatever consolation there may be in this we are welcome to.

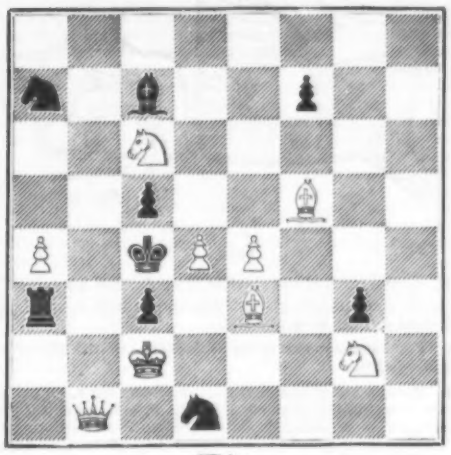
It is high time that our colleges gave some attention to this all-important matter. Experience is a good teacher, but, unfortunately, it is the patient, and not the dentist, who suffers while a sufficient stock is being secured. There should be graded steps that all should pass over in the art of filling a tooth. As well might an artist give his pupil the creation of a master for his first model as for a student to be told to fill a given cavity, without proper practical instruction.

SCIENTIFIC AMERICAN CHESS RECORD.

[All contributions intended for this department, may be addressed to SAMUEL LOYD, Elizabeth, N. J.]

PROBLEM No. 31.—Centennial Set. "Prairie Chickens."
BY R. L. C. WHITE, of *Lebanon Herald*.

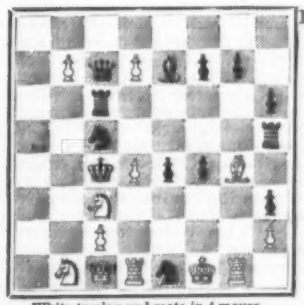
Black.



White.

White to play and mate in two moves.

R. L. C. WHITE AND THE LEBANON HERALD TOURNEYS.



White to play and mate in 4 moves.
BY S. LOYD.

BELIEVING that a portrait of the popular promoter of these famous tourneys would be as appropriate and acceptable to our readers as the likenesses of the winners, we commence by introducing Mr. White, whose ability and enterprise has gained for the chess department of the *Lebanon Herald* a reputation for excellence that has spread to the four corners of the chess world.

He is not only known as an agreeable—although at times caustic—writer, but is also recognized as a skillful player and problemist, who is however more apt to hide his light under a bushel than some of us eastern editors. We remember his winning the solvers' prize in one of the *Dubuque Journal* tourneys, but it required considerable coaxing to induce him to contribute the above little two mover to our Centennial Tournament. We have seen better specimens of his handiwork, but select this one as showing his preference for two-move problems. Both of the *Herald* tourneys were for problems in two moves, and met with an unprecedented success, eliciting competition from all the European masters.

The first prize was awarded to W. A. Shinkman, of Grand Rapids, Mich. Second prize to R. B. Wormald, of London. Third prize to C. M. Baxter, of Dundee. Honorable mention being accorded to over a dozen leading problemists.

This award of the first prize to Mr. Shinkman seems to have caused considerable dissatisfaction among some of the lesser European lights, who have shown their bad taste as well as utter incompetency as critics, in attempting to improve or amend a problem which for beauty, difficulty and ingenuity has never been surpassed, and to give problematical instructions to Mr. Shinkman, whose works entitle him to rank with Bayer and Healy.

Having been one of the umpires on the committee of award, we take especial pleasure in presenting this *pearl* to our solvers, with a perfect confidence that every true problemist will pronounce it a gem of the first water.

Mr. Shinkman has carried off the highest honors in so many tournaments, that it is too contemptible to provoke even a smile of derision to see lilliputians throwing *M yer* at him, who stand in too much awe of his prowess to meet him in any other encounter.

The umpires in this, as in all other tournaments, gave their awards without the slightest knowledge of the authorship or nationality of the competitors. In many respects, therefore, we are in favor of the plan adopted by the present tournament of *La Strategie*, who have awarded the prizes, but withheld the names of the victors for a month, as the critics never attack an award until they ascertain the nationality of the victors. The *Popular Science Monthly* says that Matthew Arnold wrote, ten years ago, that honest criticism was the great want of Europe.

The *Lebanon Herald* Tourney No. 2 is now closed, and the competitors are anxiously awaiting the award. The entire collection of problems from these interesting tournaments are to be presented shortly in book form, which will be the crowning event of Mr. White's liberal and enthusiastic labors for the cause of chess.

DE LA BOURDONNAIS AND MACDONNELL.

WE give two more selections from these famous matches, a full account of which was given in our issue of last week. The game from the third match is better known, perhaps, than any game on record, and has not only been republished the world over, and referred to in works of chess as one of the most brilliant games, but has several times been written in verse, and has a historical value as one of Macdonnell's greatest achievements.

It is worthy of note that these two celebrated antagonists, who were of the same age, should have both died in London while in their prime, and at so nearly the same date.

A visitor to Kensal Green Cemetery will find two modest looking graves, the one covered by a plain stone slab, on which is inscribed:

Sacred to the memory of
ALEXANDER MACDONNELL,
(formerly of Belfast),
Who died 14th September, 1835,
Aged 37 years.

And on the other is engraved the following inscription:

LOUIS CHARLES DE LA BOURDONNAIS,
The Celebrated Chess Player,
Died 13th December, 1840,
Aged 43 years.

DR R. L. C. WHITE.

GAME FROM THE SECOND MATCH.

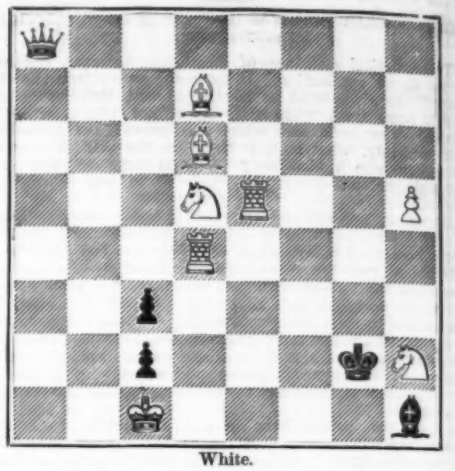
MACDONNELL.	DE LA BOURDONNAIS.
WHITE.	BLACK.
1. P to K 4	1. P to K 4
2. B to K B 4	2. P x P
3. Kt to K B 3	3. P to Q Kt 4
4. B to Q B 4	4. P to Kt 5
5. Q Kt to B 3	5. P x Kt
6. Q x P	6. Kt to Q B 3
7. P to Q 4	7. Kt x P
8. B x B P ch	8. K x B
9. Q to R 5 ch	9. K to Kt 2
10. Castles.	10. Q Kt to K 3
11. B x P	11. B to B 4 ch
12. K to R sq	12. Kt to K B 3
13. Q to R 6 ch	13. K to Kt sq
14. R to B 3	14. B to B sq
15. R to Kt 3 ch	15. K to B 2
16. Q to R 4	16. Kt x B
17. Q x Q Kt	17. P to Q 3
18. R to K B sq	18. B to K 3
19. Q to K Kt 5	19. K to K sq
20. R x Kt	20. Q to K 2
21. K R to B 3	21. P to Q B 3
22. Kt to K 2	22. R to K Kt sq
23. Q to R 5 ch	23. K to Q sq
24. Kt to Q 4	24. B to Kt 5
25. Q to Q R 5 ch	25. K to B sq
26. R to K B sq	26. B to Q 2
27. R to K B 7	27. Q to K sq
28. P to Q Kt 4	28. P to Q Kt 3
29. Q to R 6 ch	29. K to B 2
30. Q to B 4	30. B to K 3
31. Kt x B P	31. P to Kt 4
32. Q x P	32. B x Kt
33. Q to R 5 ch	33. K to Kt sq
34. Q to K B 5	34. B to Q sq
35. R to K sq	35. Q to K 4
36. Q to B 3	36. P to Q 4
37. P to Q Kt 5	37. B to Kt 2
38. R x B ch	38. K x R
39. Q to B 7 ch	39. B to B 2, and white resigned the game.

GAME FROM THE THIRD MATCH.

DE LA BOURDONNAIS.	MACDONNELL.
WHITE.	BLACK.
1. P to Q 4	1. P to Q 4
2. P to Q B 4	2. P x P
3. P to K 4	3. P to K 4
4. P to Q 5	4. P to K B 4
5. Kt to Q B 3	5. Kt to K B 3
6. B x B P	6. B to Q B 4
7. Kt to K B 3	7. Q to K 2
8. Q B to K Kt 5	8. B x K B P ch
9. K to B sq	9. B to Q Kt 3
10. Q to K 2	10. P to K B 5
11. Q R to Q sq	11. B to K Kt 5
12. P to Q 6	12. P x P
13. Q Kt to Q 5	13. Kt x Kt

PROBLEM No. 32.—By W. A. SHINKMAN.
First Prize *Lebanon Herald* Tourney.

Black.



White.

White to play and mate in two moves.

14. B x Q	14. Kt to K 6 ch
15. K to K sq	15. K x B
16. Q to Q 3	16. R to Q sq
17. R to Q 2	17. Kt to Q B 3
18. P to Q Kt 3	18. B to Q R 4
19. P to Q R 3	19. Q R to B sq
20. R to K Kt sq	20. P to Q Kt 4
21. B x P	21. B x Kt
22. P x B	22. Kt to Q 5
23. B to Q B 4	23. Kt x B P ch
24. K to B 2	24. Kt x Q R
25. R x P ch	25. K to B 3
26. R to K B 7 ch	26. K to Kt 3
27. R to Q Kt 7	27. Kt at Q 7 x B
28. P x Kt	28. R x P
29. Q to Kt sq	29. B to Q Kt 3
30. K to B 3	30. R to B 6
31. Q to R 2	31. Kt to B 5 dis ch
32. K to Kt 4	32. R to K Kt sq
33. R x B	33. P x R
34. K to R 4	34. K to B 3
35. Q to K 2	35. R to Kt 3
36. Q to R 5	36. Kt to K 6, and white resigns.

SOLUTIONS TO PROBLEMS.

No. 25.—By J. H. FINLINSON.

WHITE.	BLACK.
1. Kt to Q 3	1. R to B 5
2. Q to Q 4 ch	2. K x Q
3. R x Kt mate	
	1. B x R
2. Q to K 5 ch	2. K to B 5
3. Kt to Kt 2 mate	
	1. B x Kt
2. Q to Q 7	2. Any move
3. Q x Kt mate	
	1. Kt to K B 2
2. Q x Kt ch	2. K x R
3. Q to K 6 mate	

No. 26.—By J H. FINLINSON.

WHITE.	BLACK.
1. P to Kt 5 ch	1. K x P (best)
2. Q x B P	2. B x Q
3. R to K 5 ch	3. K moves
4. Kt mates	
	2. R x Kt
3. Q to K 7 ch	3. K x B
4. Q x P mate	
	2. B x B
3. R to K 5 ch	3. K to Kt 5
4. Q to B 5 mate	
	2. Q x B or P queens
3. Kt to K 6 ch	3. K moves
4. Q mates	

Letter "L."—By S. LOYD.

WHITE.	BLACK.
1. Kt x Kt ch	1. K x K Kt or Q Kt
2. B to B 6 or Q 6	2. Moves
3. Q or B mates	

THE REV. DR. JOHN HENRY HOPKINS, Bishop of the Protestant Episcopal Church in the Diocese of Vermont, and well known throughout the Union for his eminent piety and learning, has just given the following opinion of our game. The passage occurs in his late work, styled *The American Citizen*, at page 420.

"I do not say that he was altogether consistent in this, although I incline to the opinion that the game really deserves to be adopted as a useful branch of education. The tract of Dr. Franklin, called "The Morals of Chess," presents a very just argument in its favor. And it certainly stands on peculiar ground, being quiet, retired, and thoughtful in its tendency, taxing the understanding by the closest calculation, and never leading to the objectionable consequences which may be justly charged on almost every other. So different, indeed, is its character, that it is extensively patronized by religious and philosophical men who reject all the rest. It is never played for money. It is entirely a game of skill, and chance has no part in it. Its arrangement affords an ingenious analogy to human life and government. Such is the intellectual interest attached to it, that many books have been written on this single subject. And it is the only game in which an eminent degree of ability confers a large amount of respect and consideration."